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Building Services [ARC 2423]

PROJECT 2:
CASE STUDY, ANALYSIS AND DOCUMENTATION OF BUILDING SERVICES SYSTEMS

Setia City Mall, Shah Alam

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Introduction

The primary function of buildings is to provide shelter to its occupants but in our modern world, all building should be designed in such a way to provide an environment where peoples can feel comfortable, work, live and achieve. Basically “building services” is what make the building comes to life. They contribute largely to the sustainability of the building. There are many types of building services, as mentioned in the following chapters, and each of these provides for a different function. With a thorough study and analysis of the mentioned services systems associated to the case study, the presentation of this paper include functions, components and operation of systems, as well as implications and regulations related to different building services.

Objective

The objectives of this assignment are as follow:

1. To introduce the basic principles, process and equipment of various building services systems through real life project (experiential learning).
2. To expose the integration of various building services systems in a building.
3. To demonstratethe understanding of building services systems.
4. To developthe understanding and familiarity on the drawing conventions and standards for different building services systems.

Case Study

Setia City Mall, Shah Alam

Figure 1: Exterior view of Setia City Mall, Shah Alam.

Setia City Mall is a joint venture between Malaysian property developer S P Setia and the Asian Retail Investment Fund, a wholesale fund managed by global property and infrastructure group, Lend Lease. With over 740,000 square feet of Net Lettable Area, over 2,500 car parks and over 240 retailers spread across 4 levels, the mall is the destination of choice for shopping, dining, entertainment and park life in the area. In additionits leading local internationalretailers, the mall has also received Singapore's Building and Construction Authority (BCA) Green Mark Gold Award. The award is the latest achievement for Setia City Mall, which is the first Malaysian mall accorded the Malaysian Green Building Index Silver Award and the Singapore Building and Construction Authority Green Mark Gold Award.

Setia City Mall is equipped with the latest building management system which provides the following features:

- Centralized monitoring and control of all major mechanical and electrical (M&E) services in the building.
- Real-time control monitoring.
- Monitor M&E equipment electricity usage.
- Supports multiple open standards and legacy systems.

Building Management System

Most of the building services systems in Setia City Mall is linked and controlled by Building Management System (BMS) or a more recent terminology, Building Automation System (BAS). It is a computer-based control system, consisting software and hardware, installed in the building that controls and monitors the building's mechanical and electrical equipment such as air conditioning and mechanical ventilation system, fire protection system,building security system, electrical system, pedestrian counting system and liquid petroleum gas system. Vertical transport system and lighting system are not implemented in BMS in Setia City Mall. In overall, BMS is a critical component in managing energy demand as it represents approximately 40% of the building's energy usage.

The Building Management System (BMS) of Setia City Mall comprised of a network of various independent units, which are Controller-Network Controllers Units (NCUs) as well as main control PC to provide centralized access and facility wide control functions.

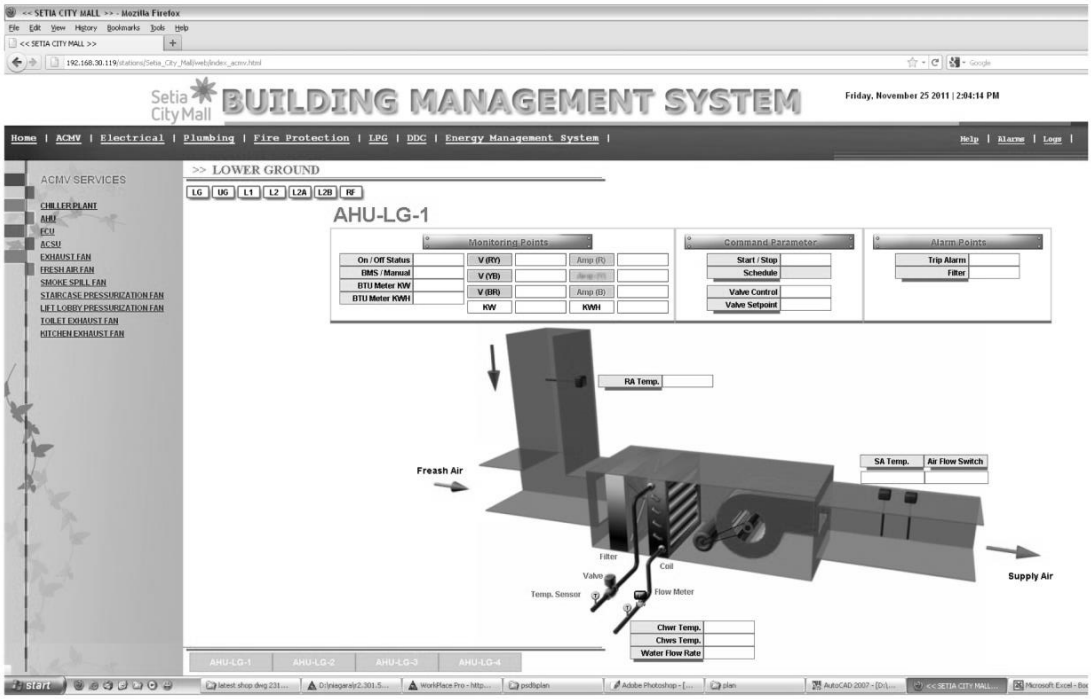


Figure2: Interface of BMS of Setia City Mall showing computer-based control system.

1.0 Electrical Supply System

1.1 Introduction

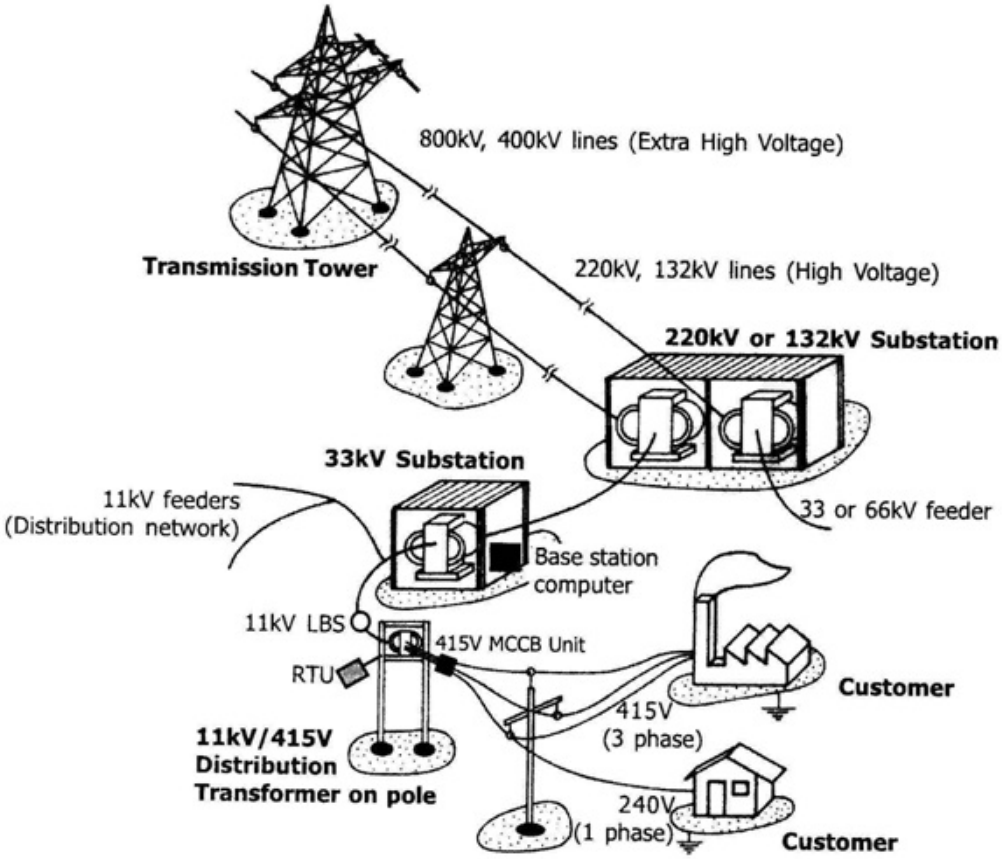


Figure 1.1: Diagram show the overview structure of electrical supply system transfer to the building.

(Source: *Determining electric grid endpoint phase connectivity*, 2014)

Electricity distribution iswhere the electrical power generating companies supply electrical power into the national 400 kV grid system of overhead bare wire conductors. This very high voltage is used to minimize the current carried by the cables over long distances. Step-down transformers reduce the voltage in steps down to 33 kV, when it can be supplied to industrial consumers and to other transformer stations on commercial and housing estates.

The electricity generating alternator rotates at 50 Hz (3000 rev/mm) and has three coils in its stator. The output voltages and currents from each coil are identical but are spaced in time by one-third of a revolution, 120°. Each coil generates a sine wave or phase voltage that has the same heating effect as a 240 V continuous direct current supply. This is its root mean square (RMS) value. The RMS value of the three phases operating together is 415 V.(Chadderton,2007)

1.2 Literature Review

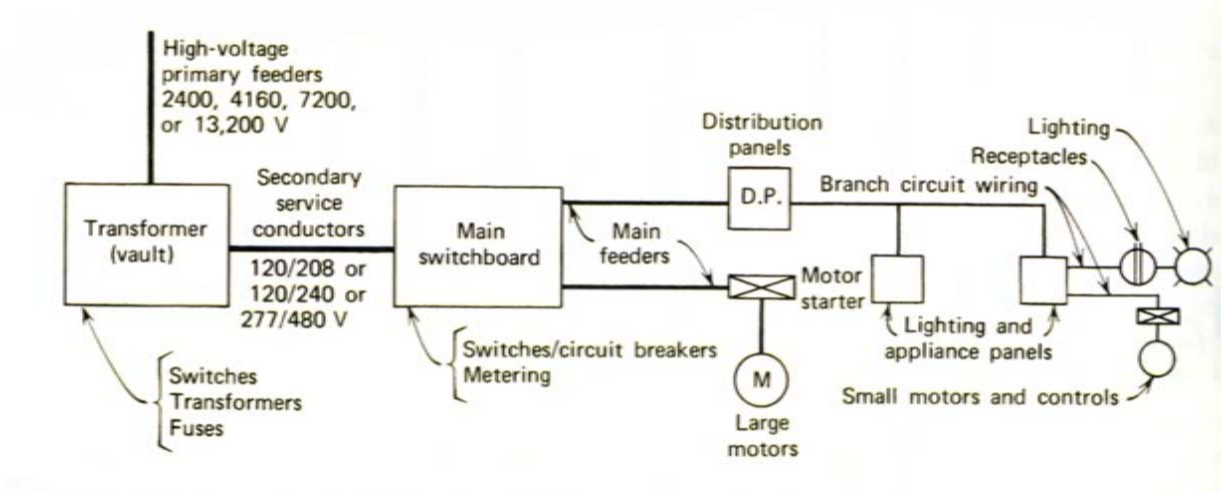


Figure1.2: Typical electrical distribution block diagram from the incoming source to the utilization |(Source: Stein, Reynolds &McGuinness, 2010)

Transformer load center is an assembly, comprising a primary voltage switch and fuse or circuit breaker, a step-down transformer, meters, controls, buswork, and secondary(low-voltage) switchgear is known as a unit substation or a load-center substation. Its function is to accept an incoming high voltage power supply, transform the high voltage to a voltage that can be utilized in the facility, and distribute the low voltage power through associated low voltage, secondary switchgear. (Fig. 1.3) Transformer is available for indoor or outdoor installation.

Figure 1.3: Transformer room. (*East view in Transformer Room during White House renovation.*, 1951)

A switchboard is a large, free standing assembly of switches and fuses or a circuit breakers, which normally provides switching and over current protection to a number of circuits connected to a single electric source. Metering and other instrumentation are also often included in the switchboard. (Fig. 1.4) This equipment serves to distribute, with adequate protection, bulk power into smaller package.

Figure 1.4: Main Switchboard and compartment. (Source: Leong Eng Gin Pte Ltd, 2014)

Electrical risers a vertical components where connect the electrical component electrical supply from floors to floors in a vertical passage. (Fig. 1.5)

Figure 1.5: Electrical Riser and compartment. (Source: *Electrical riser rooms*, 2011)

An electrical distribution panel, or panel board, serves essentially the same function as a switchboard except on a smaller scale, (Fig. 1.6)It accepts a relatively large block of power at some downstream point in a system and distributes it in smaller blocks. Like a switchboard, it comprises main buses to which are connected circuit protective devices, breakers or fuses that feed smaller circuits which mounted inside an open metal cabinet called abackbox. The backbox is prefabricated with knockouts at the top and bottom. The panel board level of a system usually represents the final distribution point, thence feeding out to the branch circuits that contain the electrical utilization apparatus and devices, such as lighting, motors and appliance panels.

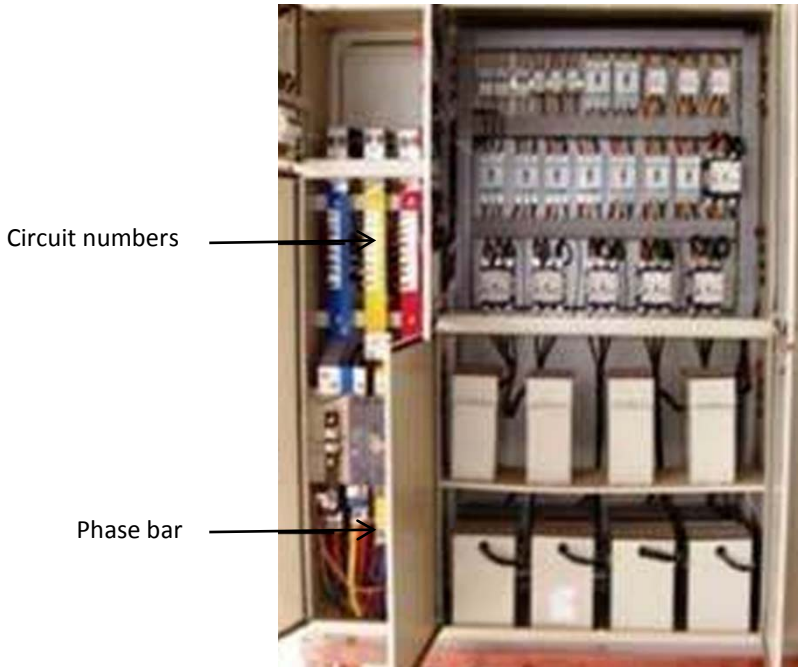


Figure 1.6: Distribution board. (Source: SnehEngitechLLP., 2014)

1.3 Case Study

1.3.1 Electrical System Component

A electrical system component consists of consumer room, transformer room, main switch board, electrical riser, distribution panel and appliance.Before the electrical supply is bring to the 33kV Transformer room. Electrical energy is redirecting from the existing PPU/PMU. It is later transfer to the 33kV TNB SSUwhere locates at the lower ground of Setia City Mall see (Fig 1.7 and Fig 1.8). Medium Voltage 6.6 kV up to 33kV is use in this mall, it adapt 3 phase configuration, solidly earthed or impedance earthed which overhead lines and underground cable are used extensively for medium voltage in this mall. Thus electrical connectivity to the mall is connected using both top and bottom transfer. The bottom entry of electrical will go through TNB Meter which located at the metering room before transfer to the Consumer Room 33kV, see (Fig 1.9). Setia City Mall is a multi-tenanted commercial premises it shall be given bulk supply. All separate kWH meters panel were installed and provided for all tenanted area. Energy sub-meters, digital power meters, DPM are provided for all major equipments energy uses, such as chiller, pumps, cooling towers, AHUs, FCUs, lifts and escalators and car park. All these digital power meters are linked to a Central Energy Management System (CEMS), so the actual building energy uses can be monitored, recorded and controlled for energy saving purpose. (Fig. 1.10)

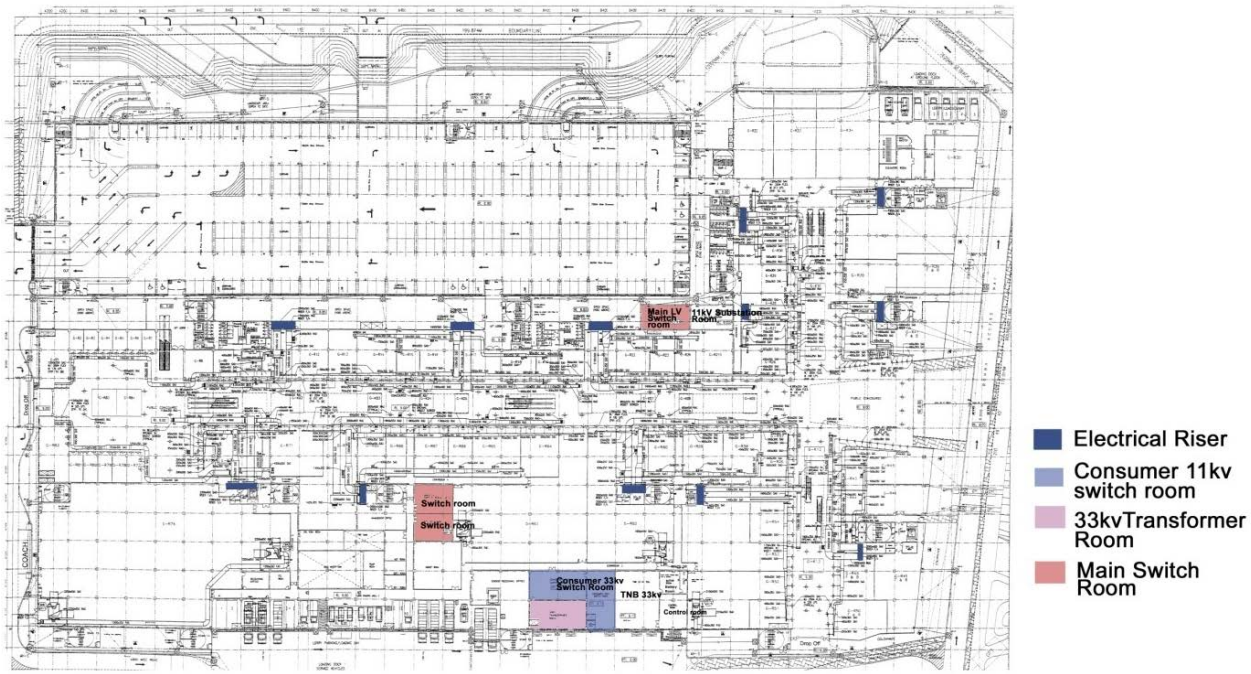


Figure 1.7: Electrical room location of Setia City Mall.

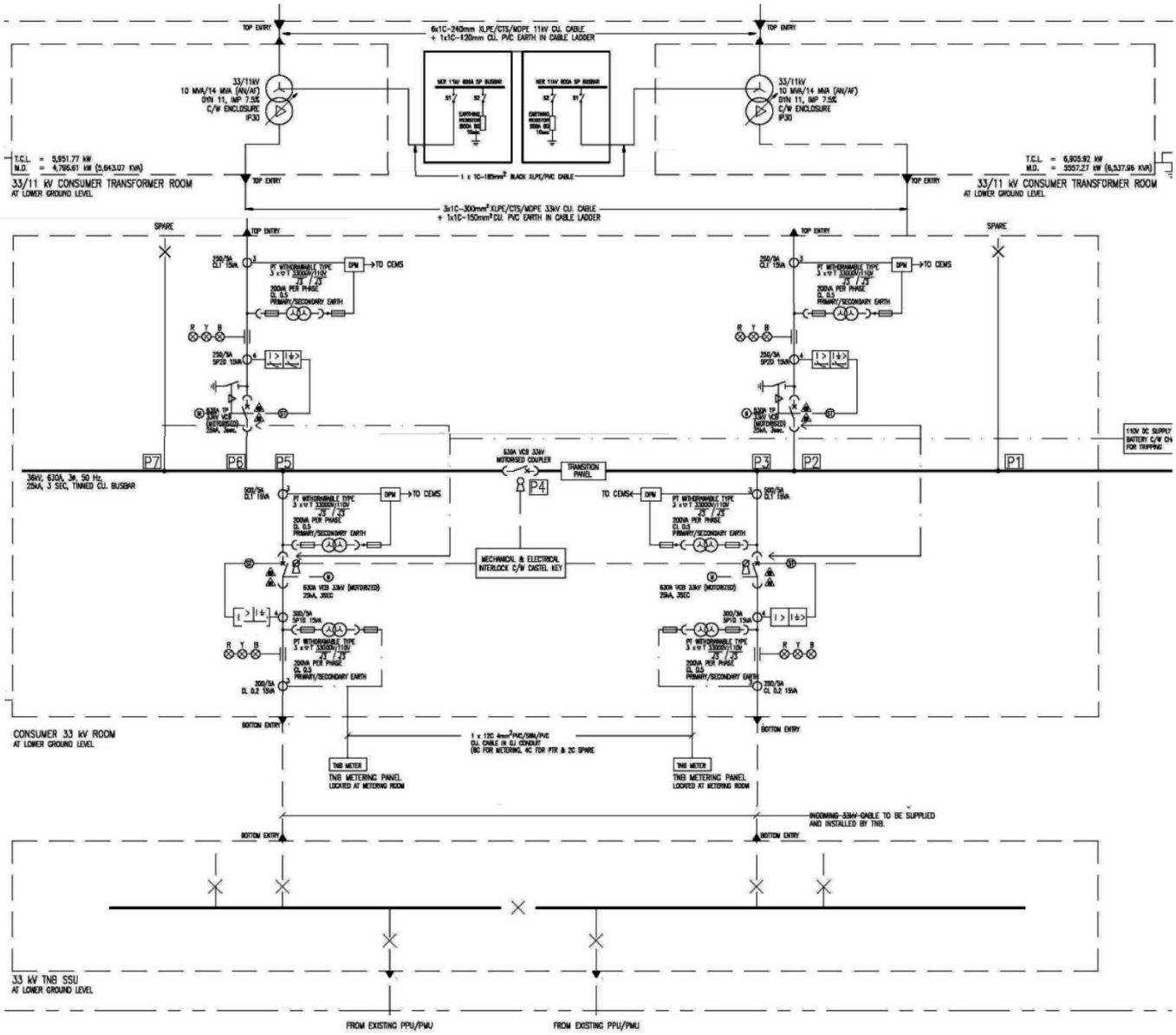


Figure 1.8: Schematic electrical distribution system of Setia City Mall.

Figure 1.9: TNB Metering (Electrical Works 6 -TNB seal, 2006)

Figure 1.10: Left digital power meters (DPM) and right Central Energy Management System (CEMS). (Source: Sanip, 2014)

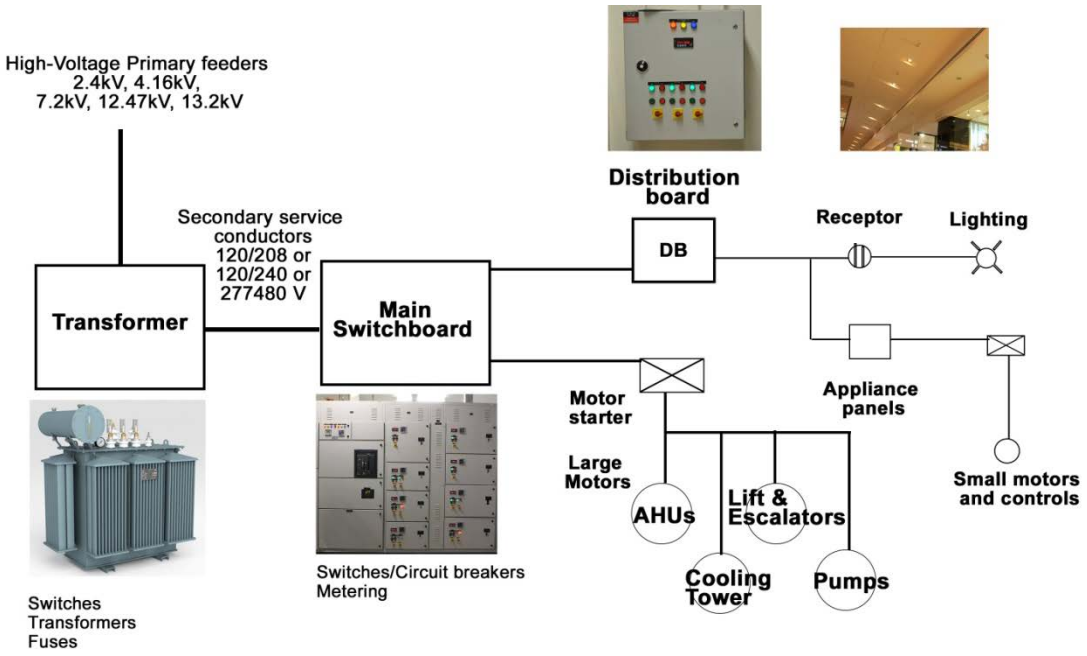


Figure1.11: Electrical distribution block diagram of Setia City Mall from the incoming source to the utilization.

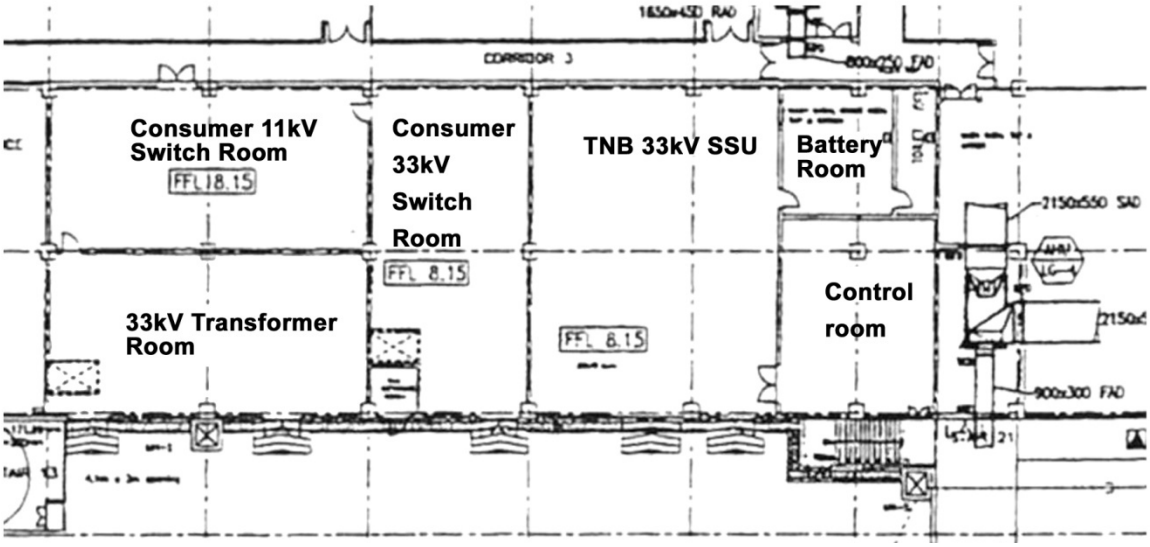


Figure 1.12: Electrical supply component location at Setia City Mall.

1.3.1.1 Transformer

The location of substation unit for Setia City Mall is installed indoor. Type of transformer is utilize dry type (air-filled transformer). Substation is locating at the lower ground floor. All the electrical component are located at Lower Ground of the mall due to need of sufficient ventilation(Fig 1.12).Transformer room is separate from theMains Switch Board (MSB) and Metering Equipment must not be installed within the distribution transformer room.(Fig. 1.13)All access to the electrical room should be restricted to authorized person.Special considerations take in depend upon the nature of the facility and may include items such as security, central or remote controls and interconnection with other facilities.

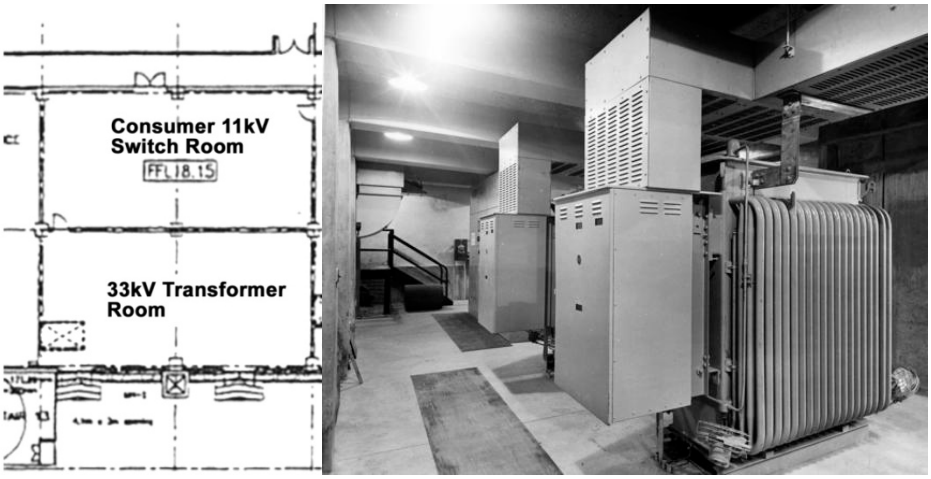


Figure 1.13: Transformer room location and Transformer unit.

Related Regulation

TS-108 –TECHNICAL STANDARD FOR DISTRIBUTION EQUIPMENT AND TRANDSFORMER ROOMS

8.5 Avoidance of Services and Encroachments

The distribution transformer room enclosure must be free of encroachments into the required floor and trench areas. Columns, beams, footpads and walls may occupy certain areas specifically shown on the distribution transformer room plans, providing it does not interfere with the location of consumer mains, conduits, trenches, ventilation ducts and distribution transformer room equipment. Ensure that the location of the distribution transformer room does not allow services such as drains, sewers and piping to pass through the:

- Distribution transformer room space, Access passageways,
- Ventilation ducts, Distribution transformer room walls,
- Distribution transformer room floors, Distribution transformer room ceiling.

The space next to all distribution transformer room access doors must be kept clear at all times.

Analysis

The construction features of an electrical room vary depending on the scope of the equipment to be installed. Floors may be reinforced to support heavy transformers and switchgear. Walls and ceilings may have to support a heavy cable tray system or busbars. Additional ventilation or air conditioning may be needed, since electrical apparatus gives off heat but the temperature must not rise beyond the tolerance of equipment. Double doors may be installed to allow for maintenance of large equipment. If utility service entrance equipment and metering is present in the room, special provisions may be made for access by utility personnel. Fire detection and suppression systems, such as carbon dioxide or water sprinklers, may be installed. Every completely enclosed switchgear room, emergency generator room, or transformer vault should be equipped with an emergency light source.(Refer to chapter 4.0 Fire Protection)

1.3.1.2 Main Switchboard

Setia City Mall low voltage switchroom located at Lower Ground where separate from the others electrical room. (Fig. 1.14) In the switch room contain main switchboard which is a large, free standing assembly of switches and fuses or a circuit breakers, which normally provides switching and over current protection to a number of circuits connected to a single electric source. Metering and other instrumentation are also often included in the switchboard. (Fig. 1.15) This equipment serves to distribute, with adequate protection, bulk power into smaller package.

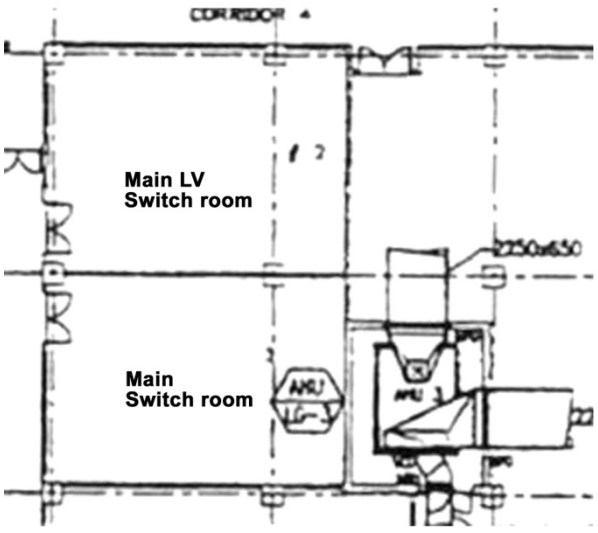


Figure 1.14: Main switch room location at Setia City Mall.

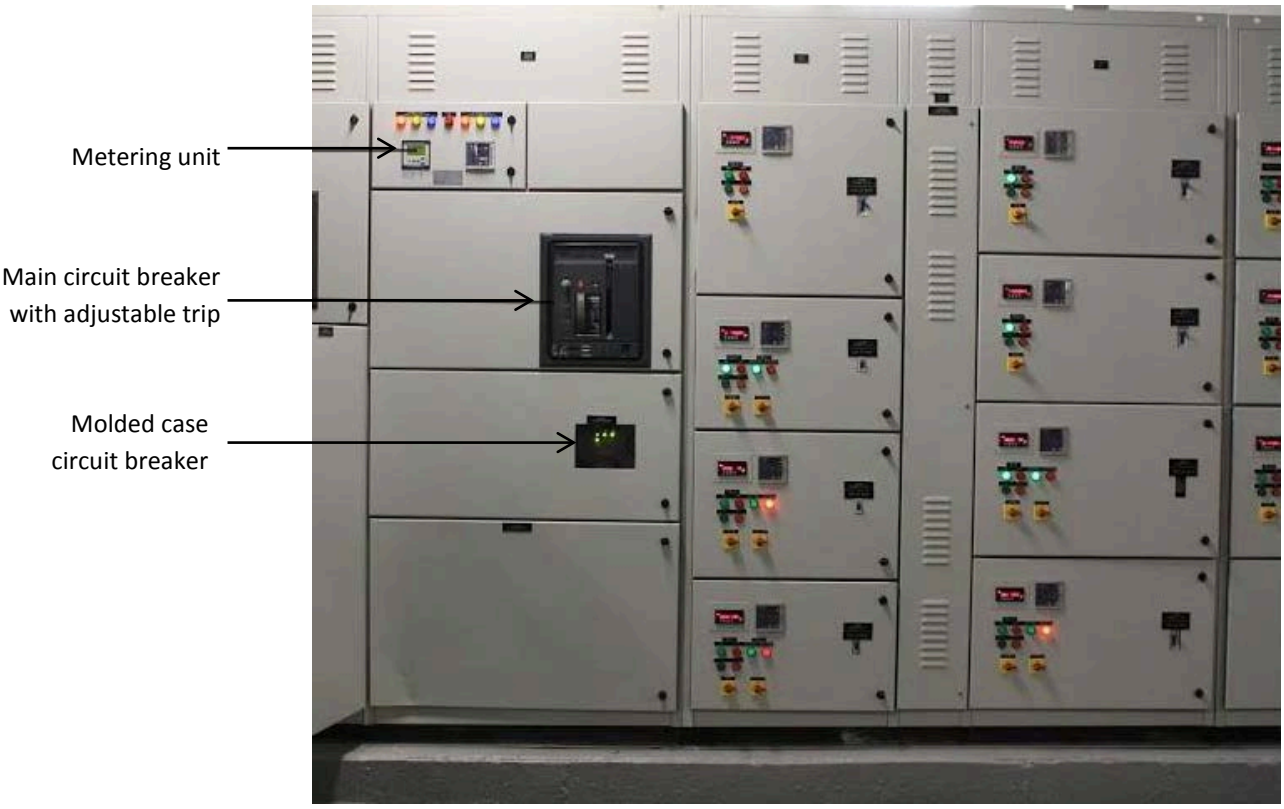


Figure: 1.15: Main switchboard

Analysis

When designing a building electric system, particularly for multistory construction. The shape of this space can be varied to fit the architectural requirements, and it should provide the following one or more locking doors and vertical stacking, above and below other electric closets, located so that it does not block conduits entering or leaving horizontally. Electrical space should free of other utilities such as piping or ducts passing through the closet, either horizontally or vertically. Sufficient wall space need to mount for all requisite and future panels, switches, transformers, telephone cabinets, and communication equipment. Wall cabinet space must be coordinated with raceway connections to under floor ducts and over the ceiling raceway systems. Sufficient floor space so that an electrician can work comfortably and safely on initial installation and repair. Beside, the space should provide adequate illumination and ventilation.

1.3.1.3 Electrical Riser

Referring to Figure 1.8, every floor of Setia City Mall were located 6 electrical risers. Every electrical riser,(Fig. 1.17) is located in an electrical closet next to the AHU's system and chillers in the building. 415V is rises then transferred to the motor. (Fig. 1.16)

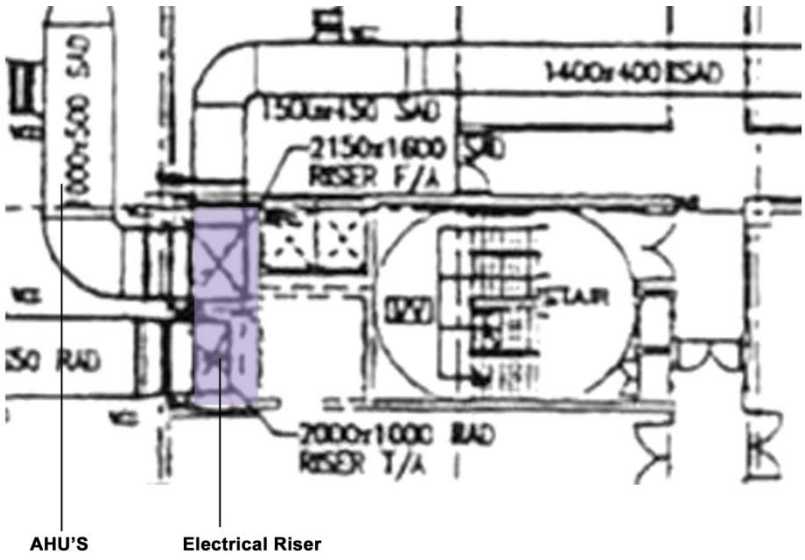


Figure 1.16: Electrical Riser location at Setia City Mall.

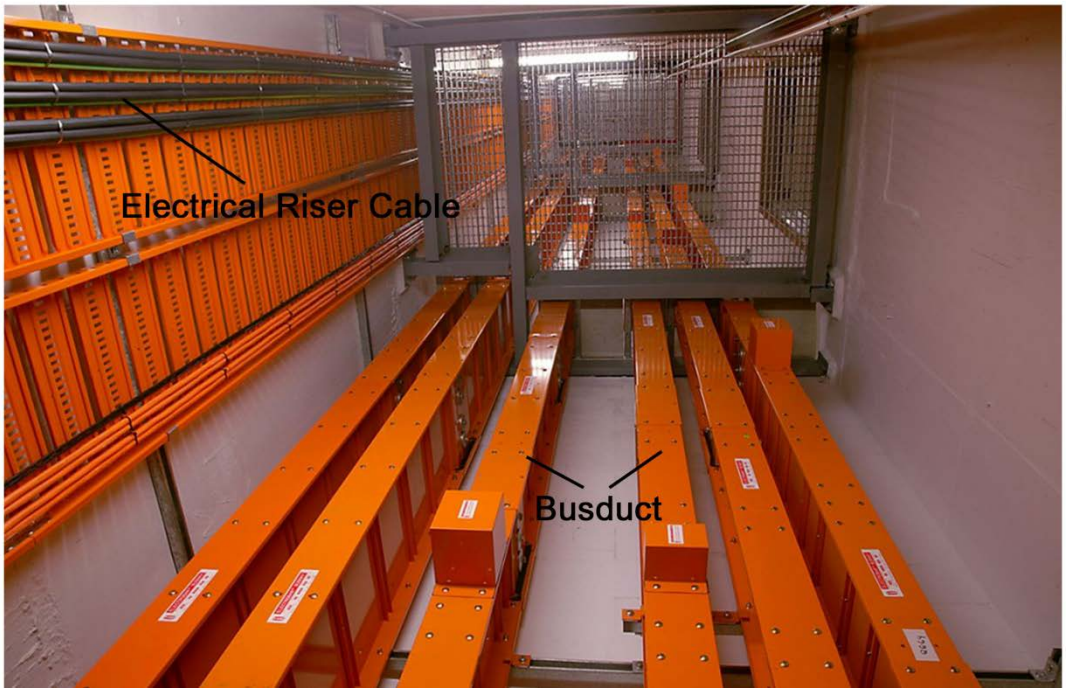


Figure 1.17: Electrical Riser and compartment. (Source: Ryan Wilks, 2010)

Figure 1.18: Electrical closet

UBBL requirement

240 Electrical isolating switch

(1)Every floor or zone of any floor with a net area exceeding 929 square metres shall be provided with an electrical isolation switch located within a staircase enclosure to permit the disconnection of electrical power supply to the relevant floor or zoned served.

(2)The switch shall be of a type similar to the fireman's switch specified in the Institution of Electrical Engineers Regulations then in force.

1.3.1.4 Distribution board

The location of the required distribution boards depends upon their type and number and upon availability of space. In this research building, were four stories high commercial spaces, an electric closet were adapt to accommodate the panel and electrical riser conduits. To limit the voltage drop on a branch circuit in accordance with code requirements, distribution boards should be located so that no circuit exceeds 100 ft (30 m) in length. If 15-A or 20-A branch circuits longer than this are unavoidable, No. 10 AWG wire should be used for runs of 100 to 150 ft (30 to 46 m) and No. 8 AWG for longer circuits. These circuits are normally wired with No. 12 AWG wire. (Fig. 1.19)

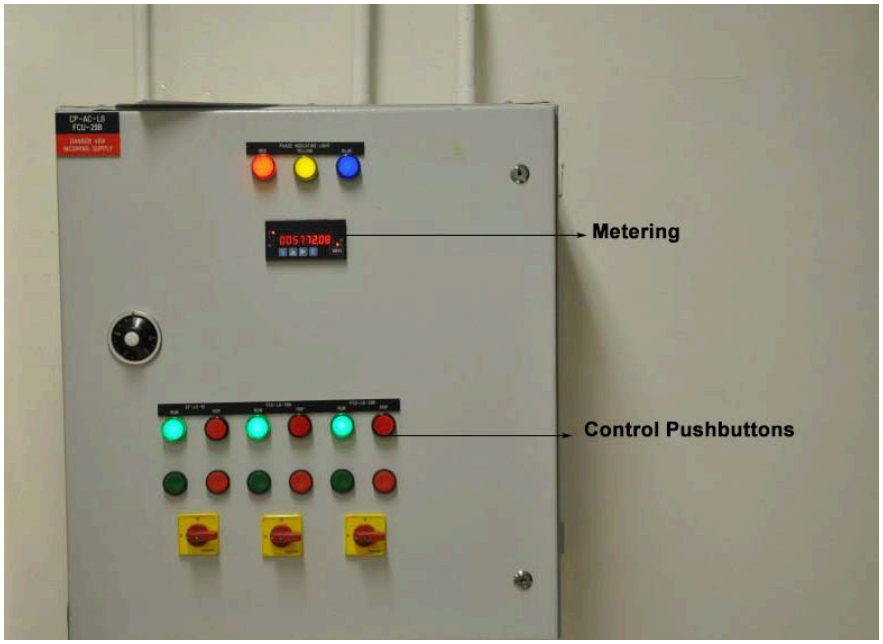


Figure 1.19: Distribution board

Analysis

The spaces required for electrical equipment in facility vary greatly, depending upon the design and the nature of the building. The working spaces required around major pieces of electrical switch gear and transformers. In large buildings, electric closets are provided to house all electrical supply equipment. Power panels and distribution panels are located as required by the loads fed through them. In general, branch circuit panels, distribution panels, and switchboards are best located near the electrical load center. This is to minimizes feeder length and reduces voltage drop, and approach the most economical arrangement. As Setia City Mall every floor same location where locate the electrical riser closet.

1.3.1.5 Battery Room

As shown in (Fig. 1.20), battery rooms is located next to the TNB Substation, where reliable power is required for operation of switchgear, critical standby systems, and possibly black start of the station. Often batteries for large switchgear line-ups are 125 V or 250 V nominal systems, and feature redundant battery chargers with independent power sources. Separate battery rooms may be provided to protect against loss of the station due to a fire in a battery bank. For stations that are capable of black start, power from the battery system may be required for many purposes including switchgear operations (Fig 1.21).

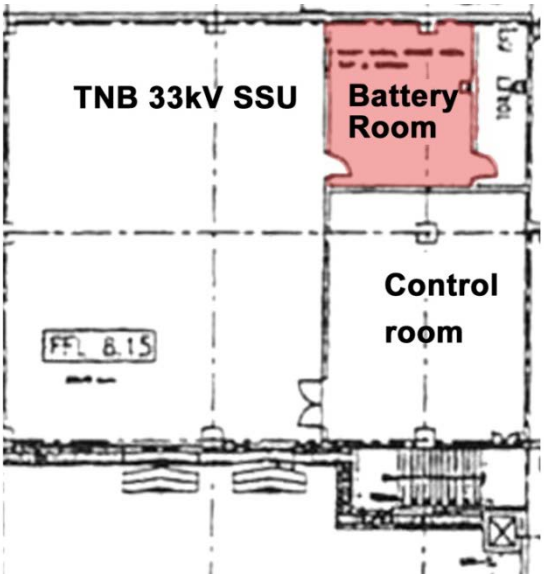


Figure 1.20 : Battery Room location at Setia City Mall

Figure 1.21: Battery Room

Analysis

Battery room is need to be locate next to the Substation. In battery rooms, battery-operated to give illumination for generator repairs in the event of generator failure or during a power outage.

UBBL requirement

253. Emergency power system.

(1) Emergency power system shall be provided to supply illumination and power automatically in the event of failure of the normal supply or in theevent of accident to elements of the system supplying power and illumination essential for safety to life and property.

(2) Emergency power systems shall provide power for smoke control systems, illumination, fire alarm systems, fire pumps, public address systems, fire lifts and other emergency systems.

(3) Emergency systems shall have adequate capacity and rating for the emergency operation of all equipment connected to the system including the simultaneous operation of all fire lifts and one other lift.

(4) All wiring for emergency systems shall be in metal conduit or of fire resisting mineral insulated cables, laid along areas of least fire risk.

(5) Current supply shall be such that in the event of failure of the normal supply to or within the building or group of buildings concerned, the emergency lighting or emergency power, or both emergency lighting and power will be available within 10 seconds of the interruption of the normal supply. The supply system for emergency purposes shall comprise one or more of the following approved types:

(a) Storage Battery

Storage battery of suitable rating and capacity to supply and maintain at not less than $87^{1}/_{2}$percent of the system voltage the total load of the circuits supplying emergency lighting and emergency power for a period of at least $1^{1}/_{2}$hours;

(b) Generator set

A generator set driven by some form of prime mover and of sufficient capacity and proper rating to supply circuit carrying emergency lighting or lighting and power with suitable means for automatically starting the prime mover on failure.

1.3.2 Electrical Appliances

Figure 1.22: Electrical appliances, downlight lighting of Setia City Mall.

Electrical appliance equipped in Setia City Mall are mainly downlight, as shown in (Fig. 1.22). Lux sensors installed at common area such as main entrance, corridor of the building, it will automatically turn the light off when the lighting level goes above 50 lux, thus it help the building saving energy. Motion sensors are also installed for all back of building area corridors, lift lobbies, toilets and staircases to switch off lighting when the space is not occupied after the operation hour. Car park lighting is also automatically reduced after the Mall closes for business. In order to complement the employment of daylight and efficiency of artificial lighting, the ceiling and columns of the car park are painted white to optimise their reflective luminosity (Fig. 1.23).

Figure 1.23: Lighting and light sensor of the mall. (Source: Sanip, 2014)

Laws of Malaysia

ELECTRICAL BY-LAWS ELECTRICITY SUPPLY ACT 1997 [ACT 447]

Apparatus,conductor,accessory,etc.

Regulation 15

Any conductor or apparatus that is exposed to the weather, water, corrosion, undue heating or used in inflammable surroundings or in an explosive atmosphere shall be constructed or protected in such a manner as to prevent danger.

Switch,switch fuse,fuse switch,circuit breaker,contractor,fuse,etc.

Regulation 16

(3) Any fuse or circuit breaker shall be

(a) constructed and arranged in such a manner so as to break the current when it exceed a given value for a sufficient time to prevent danger and

(b)constructed guarded or placed in a manner as to prevent danger of overheating,arcing or from the scattering of hot metal or other substance.

1.4 Conclusion

This case study attempts to observe and analyze the electrical supply system that function in the Setia City Mall. Site visit is conducted to the mall. Photograph and notes were taken in order to examine the electrical supply system in the mall. Based on the case study and observation, we understand how the electrical supply system were implies on a building which meet the basic requirements of space, relative height of instalment of electrical component and electrical compartment in the component. UBBL requirement or related regulation need to take in consider when design within the specific function of room space.

2.0 Cold Water Supply System

2.1 Introduction

Water supply is the provision of water by public utilities, commercial organisations, community endeavors or by individuals, usually via a system of pumps and pipes. Irrigation is covered separately from the main distribution. Water has an important role for a building because it is a basic need of human. Hence, cold water supply system is a critical part upon an erection of building to provide sufficient water supply for occupants.

2.2 Literature Review

2.2.1 Sources of Water

Water is the essence of life. There are two main categories of water supply sources, surface sources and underground sources. Surface sources are lakes, rivers, reservoirs, run off from roofs and paved areas. While, underground sources are water that trapped beneath the ground. Shallow wells, deep wells, artesian wells, artesian spring, land springs are examples of underground sources. (Hall, 2011)

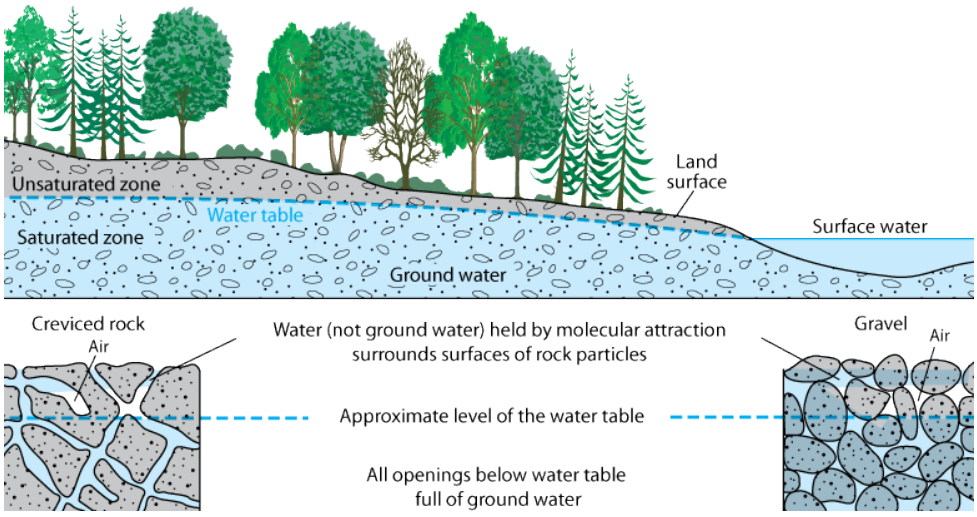


Figure 2.1: Sources of water

(Source: Centers for Disease Control and Prevention, 2009)

2.2.2 Hardness of water

Hardness of water is determined by the amount of dissolved minerals, usually referring to calcium or magnesium salts.

There are two types of hard water:

- Temporary hardness: due to the presence of calcium bicarbonate in water.
- Permanent hardness: due to calcium and magnesium sulphates in water.

The hardness of water forms scale in pipe works because pure water can dissolve the pipe work and hence affects the reduction of diameter.

Type of water	Approximate ppm
Soft	<50
Moderately Soft	50-100
Slightly Hard	100-150
Moderately Hard	150-200
Hard	200-250
Extremely Hard	>300

*Measurement: ppm- Parts per million

Table 2.1: Hardness in Water (Source: Hall, 2011)

2.2.3 Water Distribution

In Malaysia, external distribution is come from JBA, the only water supply throughout our country. However, each state has different privatized cooperation respectively. For example, Selangor and KL are under PUAS. State cooperations are responsible to maintenance work, upgrading of existing water supply, explore and develop new water supply system, ensure the safety level of water and collection of water bills. (SYABAS, 2014)

There are basically two main layouts of a distribution network:

• Branched configuration (refer to Figure 2.2)

• Grid configuration (refer to Figure 2.3)

Branched networks are predominantly used for small-capacity community supplies delivering the water mostly through public standpipes and having few house

connections, if any. Although adequate, having in mind simplicity and acceptable investment costs, branched networks have some disadvantages:

- Low reliability, which affects all users located downstream of any breakdown in the system
- Accumulation of sediments (“dead” ends) occasionally resulting in taste and odour problems
- Fluctuating water demand producing rather large pressure variations

Branched systems are easy to design. The direction of the water flow and the flow rates can readily be determined for all pipes. This is different in looped distribution networks, where consumers can be supplied from more than one direction.

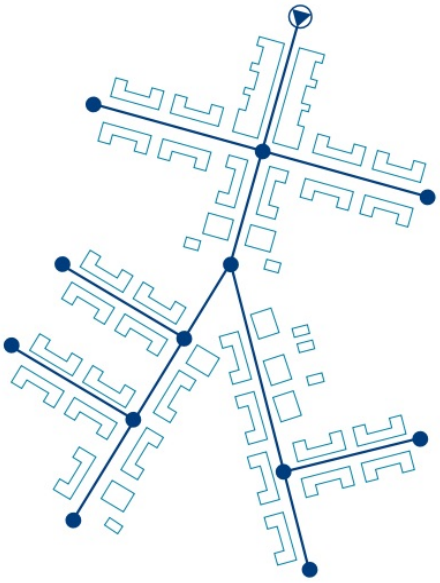


Figure 2.2: Branched Distribution System (Source: Trifunovic, 2014)

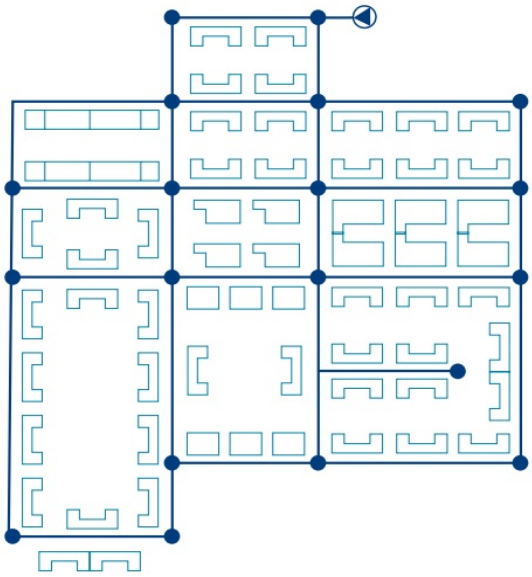


Figure 2.3: Grid Distribution System(Source: Trifunovic, 2014)

As shown in Figure 2.3, grid networks greatly improve the hydraulics of the distribution system. This is of major importance in the event that one of the mains is out of operation for cleaning or repair. The secondary mains are connected to one or more loops or rings. The network in large (urban) distribution systems will be much more complex (Figure 2.4); essentially a combination of loops and branches with lots of interconnected pipes that requires many valves and special parts. To save on equipment costs, over-crossing pipes that are not interconnected may be used but at the cost of reduced reliability.

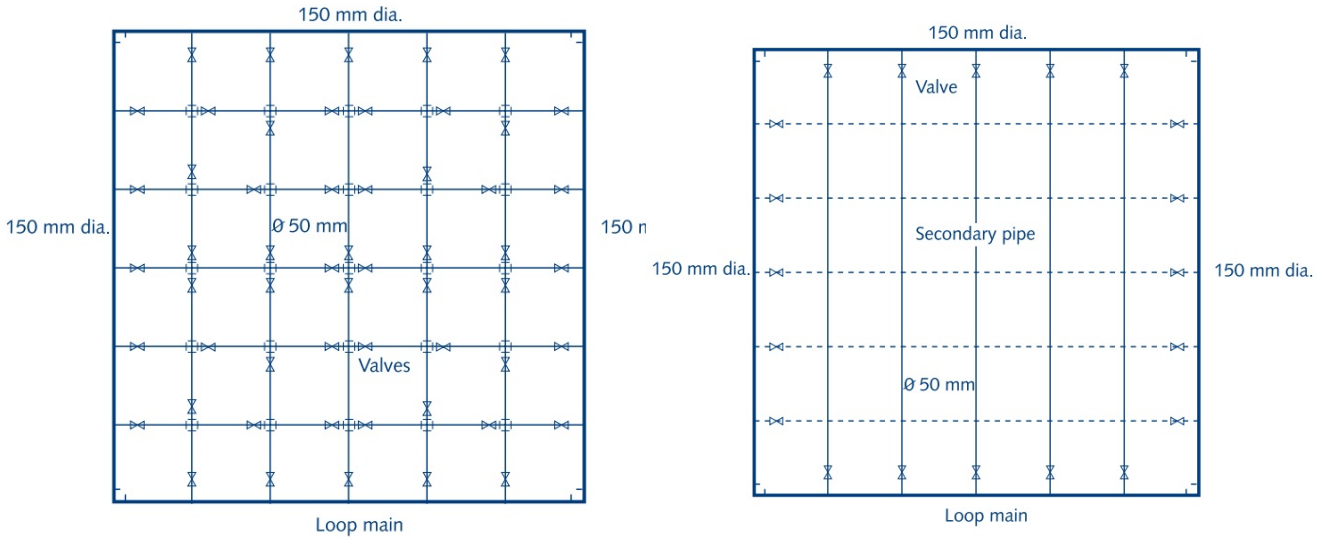


Figure 2.4: Fully Interconnected Pipe over Crossing Single Pipes(Source: Trifunovic, 2014)

2.2.4 Acidity and Alkalinity of Water

The quality of processed water is unlikely to be pure due to contamination at source.Rainwater is contaminated by suspended impurities as it falls through the air. These impurities are principally carbon dioxide, sulphur and nitrous oxides originating from domestic flue gases and industrial manufacturing processes. On the other hand, the surface and substrata water sources are contaminated by dissolved inorganic materials such as calcium, magnesium and sodium. The following table shows the quantity of pollutant microbes present during the stages of water processing:

Source/ Process	Typical pollutant microbe count per litre
River	41000
Impounding Reservoir	1500
Primary Filter	500
Secondary Filter	50
Chlorination	0
Service Reservoir	0
Distribution Main	0

Table 2.2: Quantity of Pollutant Microbes(Source: Hall, 2011)

2.3 Case Study

According to location of Setia City Mall, which is located at Klang Valley, Selangor, water supply system is under control of PUAS, the state cooperation of water distribution. After inducing incoming water from SYABAS by service pipe, water will first reach RC domestic water storage tank at lower ground level. Figure 2.3.1 shows the distribution of water throughout Setia City Mall.

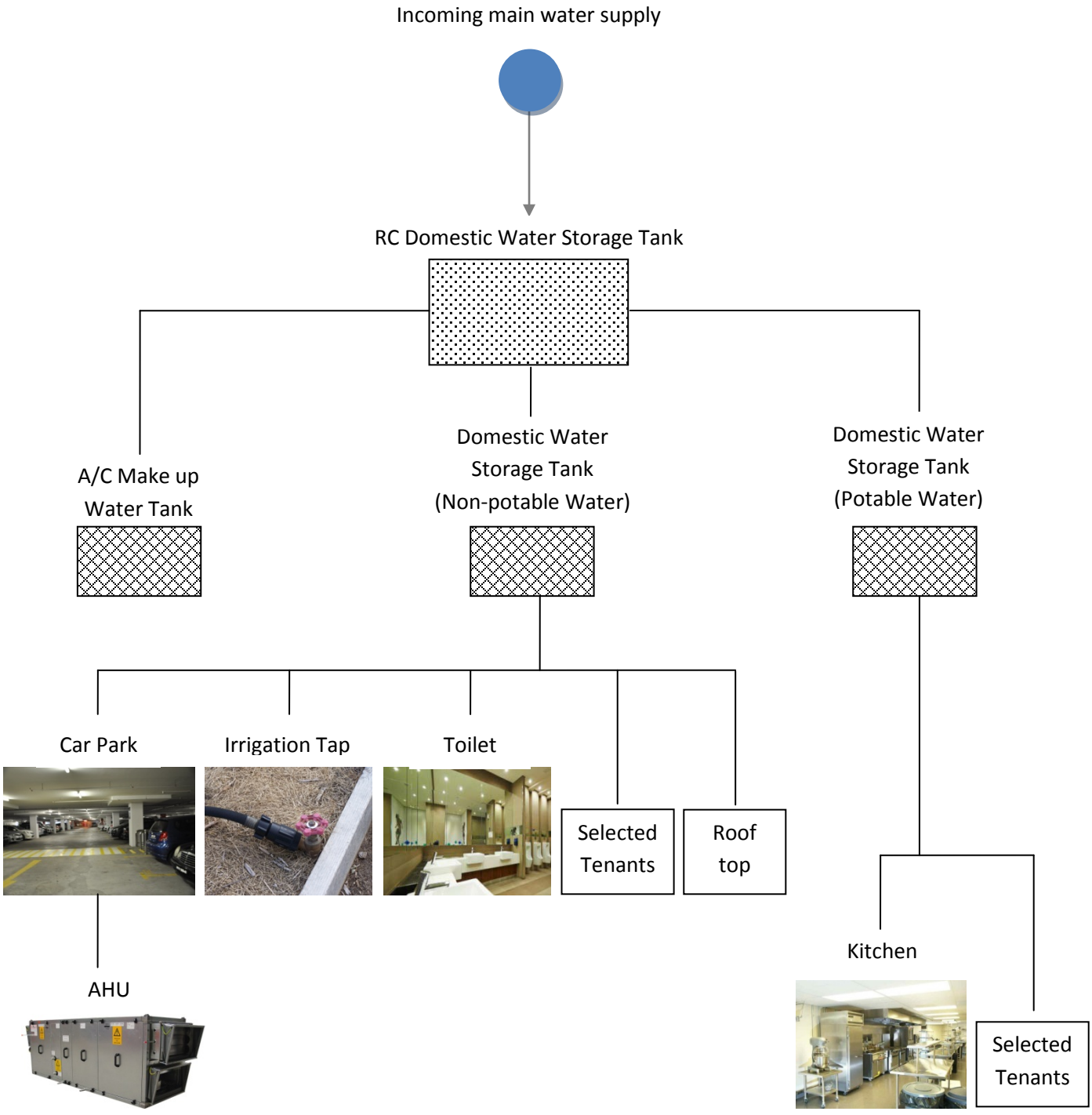


Figure 2.5: Water distribution of Setia City Mall

According to the needs of Setia City Mall, cold water supply are come from three categories of water tank, which are A/C make up water tank, domestic water tank for potable water and domestic water tank for non-potable water. Water in these tanks is supplied from an RC domestic water storage tank. (Fig. 2.6)

As shown in Figure 2.7, A/C make up water tank provides water to AHU and cooling tower for mechanical ventilation system. There are two domestic water tanks inspected in Setia City Mall. Non-potable water tank supplies water with three distribution pipes, to provide water to car park, Air Handling Unit, roof level and toilets. Instead, potable water tank provides drinking water for kitchens and selected tenants according to the respective needs. Potable water is filtered before distributed into each space with UV filter.

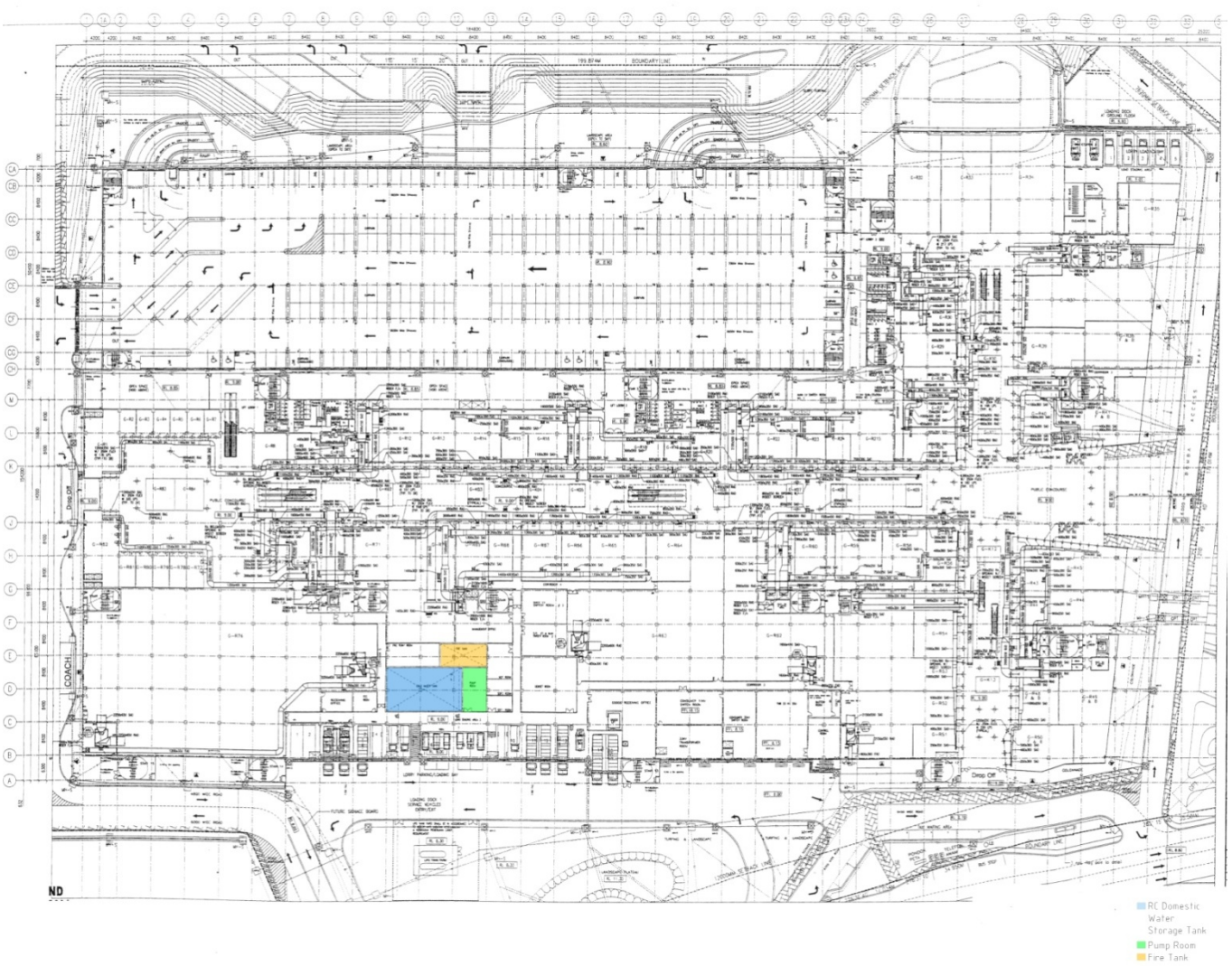


Figure 2.6: Location of RC Domestic Water Storge Tank, pump room and fire tank at Lower Ground Floor

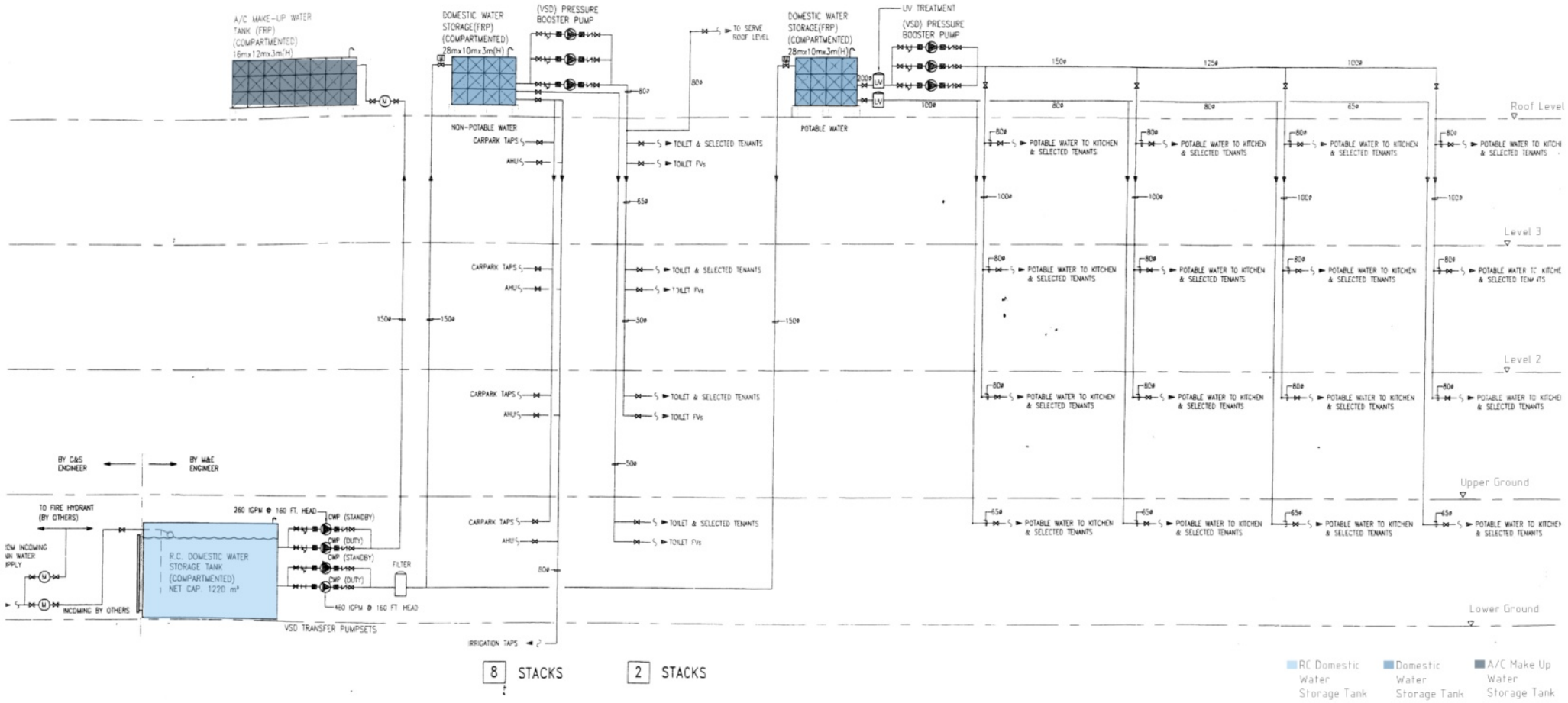


Figure 2.7: Schematic Water Supply System of Setia City Mall

2.3.1 Water Fittings

2.3.1.1 RC Domestic Water Storage tank

The RC Water storage tank with a volume of 1330m^3 is required to store the incoming water from SYABAS, and then to give water supply to the entire Setia City Mall. It is crucial to design an optimum size water storage tank. Before the incoming water has reached RC domestic water storage tank at the lower ground floor, there is a service pipe that connects the incoming water to fire tank for fire protection system. Hence, the water store inside this water tank is used for entire water supply system of this building excluding fire protection system.

Distribution pipe of 150mm diameter are installed in between RC Domestic water tank and A/C Make up water tank and the two domestic water tanks. Moreover, there are CWP, Cold Water Pump and Sand Filter as intermediate connector.

Figure 2.8: RC Domestic water storage tank(Source: CS Industry, n.d.)

2.3.1.2 Domestic water storage tank

After passing through RC domestic water storage tank, water will flow into domestic water tank at the roof level. There are three domestic water storage tanks on the roof top of Setia City Mall, which are A/C Make up water tank, domestic water storage tank for potable water and non potable water.

To serve as a storage for providing chilled water to Air Conditioner of Setia City Mall, A/C Make up watertank has a size of 16m x 12m x 3m(h) to store sufficient water for A/C.

Figure 2.9: A/C make up water tank(Source: EBay, n.d.)

For the both non potable and potable water storage tank, both of the tank shares same dimension which is 28m x 10m x 3m to suit for the daily usage of Setia City Mall.

Figure 2.10: FRP domestic water tank at roof top level

Non potable water which is processed through sand filter is provided to car park taps, AHU, toilet appliances and selected tenants as requested.Due to the water of this tank is for potable water usage, UV filter is used to ensure that the potable water is safe to use. The potable water must be well treated to reach the standards and regulations that are proposed by WHO. Table 2.4.2.1 shows the Service level and quantity of water collected.

Service level	Distance/time	Likely volumes of water collected	Public health risk from poor hygiene	Intervention priority and actions
No access	More than 1 km / more than 30 min round-trip	Very low: 5 litres per capita per day	**Very high** Hygiene practice compromised Basic consumption may be compromised	**Very high** Provision of basic level of service Hygiene education Household water treatment and safe storage as interim measure
Basic access	Within 1 km / within 30 min round-trip	Approximately 20 litres per capita per day on average	**High** Hygiene may be compromised Laundry may occur off-plot	**High** Provision of improved level of service Hygiene education Household water treatment and safe storage as interim measure
Intermediate access	Water provided on-plot through at least one tap (yard level)	Approximately 50 litres per capita per day on average	**Low** Hygiene should not be compromised Laundry likely to occur on-plot	**Low** Hygiene promotion still yields health gains Encourage optimal access
Optimal access	Supply of water through multiple taps within the house	100–200 litres per capita per day on average	**Very low** Hygiene should not be compromised Laundry will occur on-plot	**Very low** Hygiene promotion still yields health gains

Table 2.3: Service level and quantity of water collected
(Source : Domestic water quantity, service level and health, 2013)

Standard Requirement

Drainage, Water Supply and Stormwater Drainage, 2000

2.5 Supply Tanks

2.5.1 Cold water storage tanks must be provided in the following cases:

A. In buildings of more than two storeys;

B. where the water supply is poor and

C. to meet fire protection requirements

Analysis

To accommodate with the level of incoming water from SYABAS, the main water tank, RC domestic water storage tank is placed at the same level as incoming water. Due to the commercial context of this building, it is included of four levels to provide sufficient space for commercial activities to be conducted. Domestic water tanks are placed at roof level to serve the use of gravity transportation of water.

The three domestic water tanks, A/C Make up water tank, Domestic water storage tank for potable water and non-potable water are separated to function as different compartment. This arrangement is to ease the technician to inspect the water usage and water quality accordingly and systematically. On the other hand, the sizes of water tanks are designated to suit the water usage of Setia City Mall according to their function.

In material wise, water storage tank at the lower ground floor is made of reinforced concrete to lower maintenance costs over the life of the structure when compared with steel tanks. For the domestic water tanks on roof top, Fibre Reinforced Plastic (FRP) is used as material. FRP Chemical Equipments are manufactured mainly by Hand Lay-up and filament winding processes. BS4994 still remains a key standard for this class of items. Fibreglass tanks are structurally strong, corrosion-resistant, watertight, lightweight and easy to install. Due to its light in weight, it is suitable to be installed at the roof top. (Science Direct, 2005)

2.3.1.3 Cold Water Pump and Pressure Booster Pump

The usage of CWP in between the two water tanks is to pump water from the RC water storage tank to A/C Make up water tank and domestic water storage tanks, from the ground level to roof top level. Once the water arrives in roof top and need to be exported to the next distribution pipe at lower levels, gravitational distribution and pressure booster pumps are used to create larger flow of water according to requirement of each service space.

Pressure Booster pump with variable speed drive (VSD) is placed before water from domestic water storage tank to the respective services area to boost the flow of water. This is due to the large usage of potable water, hence a huge flow of water need to be provided.

Figure 2.11: Pressure booster pump

Analysis

Setia City mall utilizes the combination of gravity and pressure pump as a method of water distribution throughout the whole building. Incoming water from SYABAS is come from lower ground level, so that it needs CWP (Cold water pump) to send the water to roof level. Consequently, water will be boosted into the A/C make up water tank and domestic water storage tanks on the roof. Thus, water from these tanks can be exported to respective distribution pipes with gravity. This arrangement is an advantage for cutting the cost of mechanical energy in pressure pump.

2.3.1.4 Water Meter

Water meters are installed at the discretion of the local water authority. Most require meters on all new build and conversion properties, plus existing buildings which have been substantially altered. (Hall, 2011)

Figure 2.12: Water Meter(Source: Direct Science, n.d.)

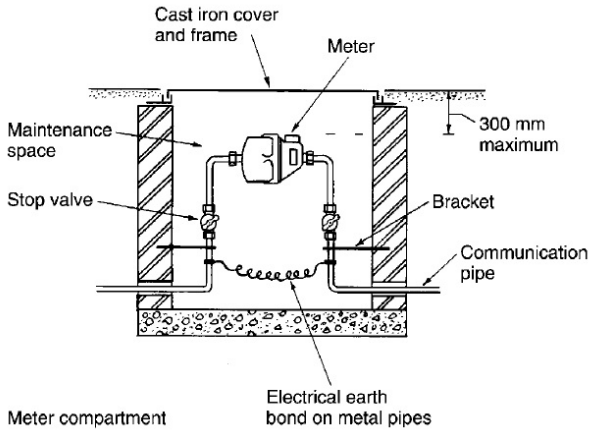


Figure 2.13: Section of water meter(Source: Hall, 2011)

Standard Requirement

Drainage, Water Supply and Stormwater Drainage, 2000

2.1 Domestic use and Fire protection

Water meters are normally provided and installed by the Local Authority.

Analysis

Water meters are placed before each of the water tanks throughout Setia City Mall. This is to ensure and accurately estimate the amount of usage of respective water tank. Hence, if there is any abnormal usage amount of water, technician can quickly locate the position of it and inspect the issue within the shortest time.

2.3.1.5 Water Filters

Water Quality of Malaysia is National Standard for Drinking Water Quality (Second Version, January 2004) issued by Engineering Services Division, Ministry of Health, Malaysia. This is adopted from the World Health Organization (WHO) guidelines for drinking water quality. Table shows the drinking water quality standards of Malaysia. (SYABAS, 2014)

Parameter	WHO
pH	6.5-8.5
Turbidity	< 5 NTU
Colour	<15 Hazen
Free Residual Chlorine	0.2-2.0 mg/L
Residual Aluminium	<0.1 mg/L
Fluoride	<0.7 mg/L

Table 2.4: Parameter of water(Source: WHO, 2014)

Hence, water filter has an important role for water quality controlling. There are two types of water filters that are utilized in Setia City Mall, that are sand filter and UV filter.Sand filter has a rate of filtration 0.2 to 1.15 m 3 per m 2 per hour. Filter beds can occupy large areas and the top layer of sand will require removal and cleaning at periodic intervals. (Hall, 2011) It is placed at lower ground, same level as the RC domestic water storage tank to filter the incoming water to be further distributed to respective systems.There are two UV filters placed at roof level to filter water from RC domestic water storage tank to give further treatment to the potable water that store inside domestic water tank.

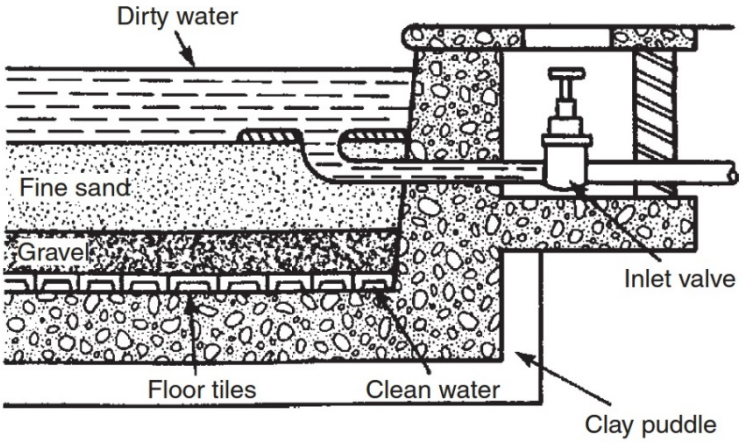


Figure 2.14: Section of Sand Filter(Source: Hall, 2011)

Analysis

Due to the quality of water standard that are proposed by Ministry of Health in Malaysia, sand filter and UV filter are used at different water tanks in Setia City Mall according to the function of water. Sand filter is used for non potable water while UV filter is used for potable water. They are placed at appropriate position to be functioned well.

2.3.1.6 Piping

As a commercial building, the dimension of water pipes throughout Setia City is larger than residential building. This may allow larger amount of water to be supplied into each spaces due to large usage amount of this commercial building.

The service pipe from RC water storage tank is 150mm in diameter, which provide a larger flow of water to the other three water tanks at the roof level. After passing through pressure booster pump, a distribution pipe of 80mm diameter is used, before it connects to the appliances with pipes of 65mm are connected with 50mm diameter distribution pipes. For the potable water domestic water storage tank, 200mm diameter pipe is connected with the UV filter. After that, 125mm and 100mm diameter distribution pipes are used to induce water to respective spaces. Appliances are connected to distribution pipes with 80mm diameter pipes. (Fig. 2.15)

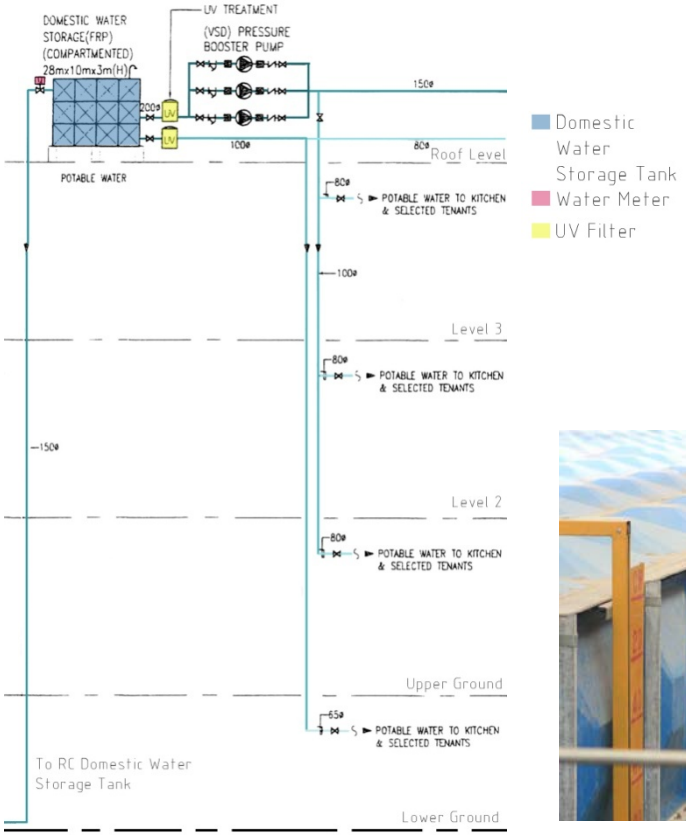


Figure 2.15: Dimension of distribution pipes in Setia City Mall

Figure 2.16: 200mm diameter pipe is connected with the UV filter at roof level

Analysis

According to standard regulations, the dimension, types of material must be shown on the distribution pipe. Setia City mall has achieved this requirement as shown in Figure 2.4.6.2. Other than that, cold water pipe work above ground level, but concealed in roofs and ducts etc. may be of galvanized iron, thin wall hard drawn copper or stainless steel, for all diameters.(DRAINAGE WATER SUPPLY AND STORM-WATER DRAINAGE, 2000) For example, pipe works in Setia City Mall consists of variety sizes according to the requirement. Moreover, water pipes are inspected to be exposed in this building to facilitate maintenance.

Laws of Malaysia

UBBL 1984

UBBL By-Law 89, Chases

A chase made in wall for pipes and other service facilities shall leave the wall at the back of chase, not less than 100mm thick in external walls and not less than 100mm thick in party wall and shall be not wider than 200mm.

UBBL By-Law 123, Pipes and Service Ducts

(1) Where ducts or enclosures are provided in any building to accommodate pipes, cables or conduits the dimension of such ducts or enclosures shall be-

(a) Adequate for the accommodation of the pipes, cables or conduits and for crossing of branches and mains together with supports and fixing; and

(b) Sufficiently large to permit; access to cleaning eyes, stop cocks and other controls there to enable repairs, extensions and modifications to be made to each or all of the services accommodated.

(2) The access openings to ducts or enclosures shall be long enough and suitably placed to enable lengths of pipe to be installed and removed.

2.3.1.7 Gate Valve and Ball Valve

Gate valve and ball valve are installed systematically throughout Setia City mall. As shown in Figure 2.17, gate valve and ball valve are utilized accordingly at part of lower ground floor. The valve is used to control the flow of water on low pressure installations. The wheel head is rotated clockwise to control the flow of water. Ball valves are installed at the distribution pipes that are branched out from gate valve to provide water flow control at more specific water fittings. As shown in Figure 2.18, gate valve and ball valves are installed respectively according to the requirement of water control, hence to ease the technician's convenience to carry out maintenance work.

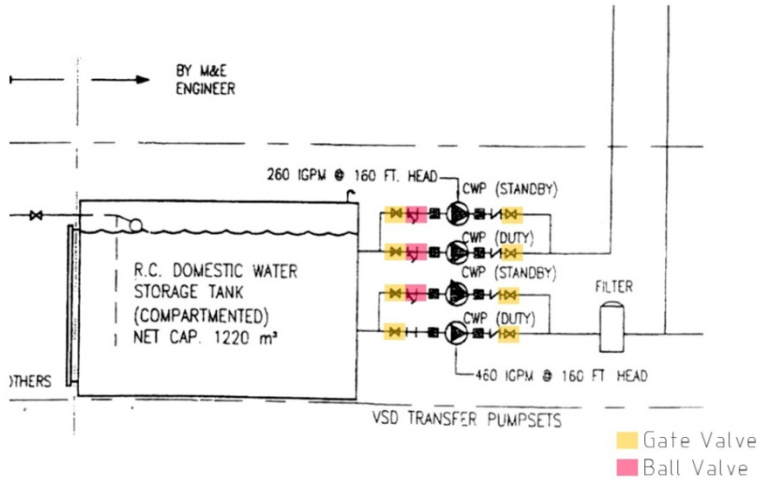


Figure 2.17: Part of distribution of Gate Valve and Ball Valve at lower ground floor

Figure 2.18: Sand Filter, Gate Valve, Pressure Booster Pump, Distribution pipe at Lower Ground Floor

Analysis

Isolating valves on water reticulations are shown at all important points, for example a water supply line to a ball valve. Distributions of valves are critical because it is important to control the flow of water during emergency case.

2.3.2 Appliances

2.3.2.1 Water Basin

Water basins are distributed in toilets and selected tenants according to requirements. The water basin of toilet is designed with a height of from the ground with consideration of handicapped occupants. Figure 2.20 shows the standard dimension requirement of water basin in toilet.

Figure 2.19: Water Basin at toilet

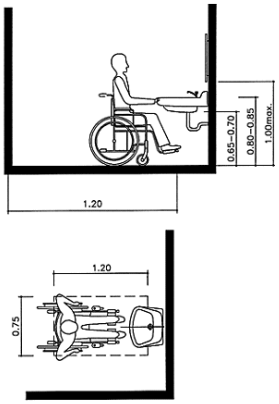


Figure 2.20: Standard dimension (Source: Designm, n.d.)

2.3.2.2 Flush Valve Seals

Water supply is distributed from a pipe of 65mm diameter to flush valve seals of cubicle inside each water closet. Moreover, there are stop cock installed alongside with each flush valve seals to ease the control of water flow.

Figure 2.21: Control of cubicle flush

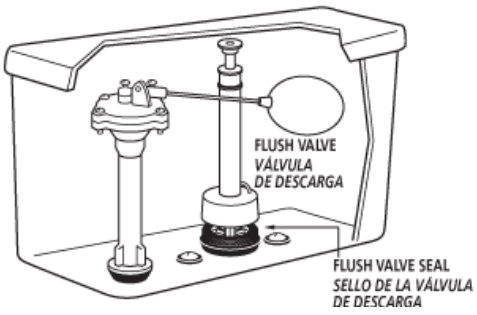


Figure 2.22: Flush Valve Seals(Designm, n.d.)

2.4 Conclusion

Designing water supply system with consideration of the occupants' requirement is important during an erection of building because this could ensure a long lived system. Design with adequate water pressure and specific rate of flow need to be achieved in order to prevent any overflow or lack of water supply. Other than that, maintenance is also need to be conducted routinely to protect the system. At the same time, due to the large usage amount of water, climate change, rising of population and rising energy cost are also contemporary issues to be tackled with while designing water supply system, to develop a comparatively sustainable commercial building and lower the environmental impact.

3.0 Sewerage System

3.1 Introduction

Sewerage system is one of the most important infrastructures and it plays an important role in determining public health, environmental protection and enhancing the quality of life enjoyed by a community. Sanitary sewers are constructed primarily to transport the wastewater of a community to a point of treatment or ultimate disposal. Sewerage refers to the infrastructure that conveys sewage. It encompasses components such as receiving drains, manholes, pumping stations, storm overflows, and screening chambers of the combined sewer or sanitary sewer. Sewerage ends at the entry to a sewage treatment plant or at the point of discharge into the environment. Studies have proved that an average person in the industrialized world produces between 60 and 140 gallons of sewage per day.

3.2 Literature Review

Wastewater may be defined as a combination of the liquid (or water) carrying wastes discharging from toilets, cooking and washing, industry as well as stormwaterfrom residences, institutions, commercial and industrial establishments. Generally, wastewater discharged from domestic premises like residences, institutions and commercial establishments is termed as “sewage” or “community wastewater”, which comprises of 99.9% water and 0.1% solids. It is mainly organic due to its carbon compounds content from human waste, paper, vegetable matter etc. On the other side, industrial wastes are also organic in composition. However, the process involved in the treatment process is more complicated than community wastewater. Sewerage discharged from both sources can be be treated physico-chemically or by micro-organisms for protection of the environment in a manner commensurate with public health and socio-economic concerns.

Sewerage system usually consists of sewer pipes, pump stations, sewage treatment plants and sludge treatment facilities. As a way to reduce cost required for pumping, this system usually operates based on by gravity with a network of underground pipes designed in sloping degree. The sewerage system adopted in Malaysia is a separate sanitary and stormwater sewer system, which means wastewater is transported in separate pipes from storm sewers, industrial sewers and sanitary sewers. This system will not experience CSOs (Combine Sewer Overflows)

which usually happens to combined sewer. Thus, the flooding will cause by stormwater only. (Essays UK, 2013)

Sewers are further classified into a few categories, which depend on the type of wastewater that each of it carries. In such, carry stormwater from roofs, paved areas, pavements and roadsare designedto carry by storm sewers; industrial sewers are designed to carry wastewater generate from the industry; whereas sanitary sewers are designed to carry the waste water from cooking and washing and the wastes from toilets. Besides, there is also a classification for combined sewer type, which is meant to carry a mixture of stormwater, industrial wastes, and domestic sewage. The flow of waste water could affect the efficiency of sewerage system. Thus, design consideration of the type and size of pipe to be used must meet the accommodation of peak flow. The peak flow is based on the population equivalent which is a direct measurement of the population in an area. There is standard and criteria that should be followed in design consideration. The standard code of practice for sewerage design in Malaysia (MS 1228:1991) was adopted from British Standard(BS 8005:1987).

3.3 Case Study

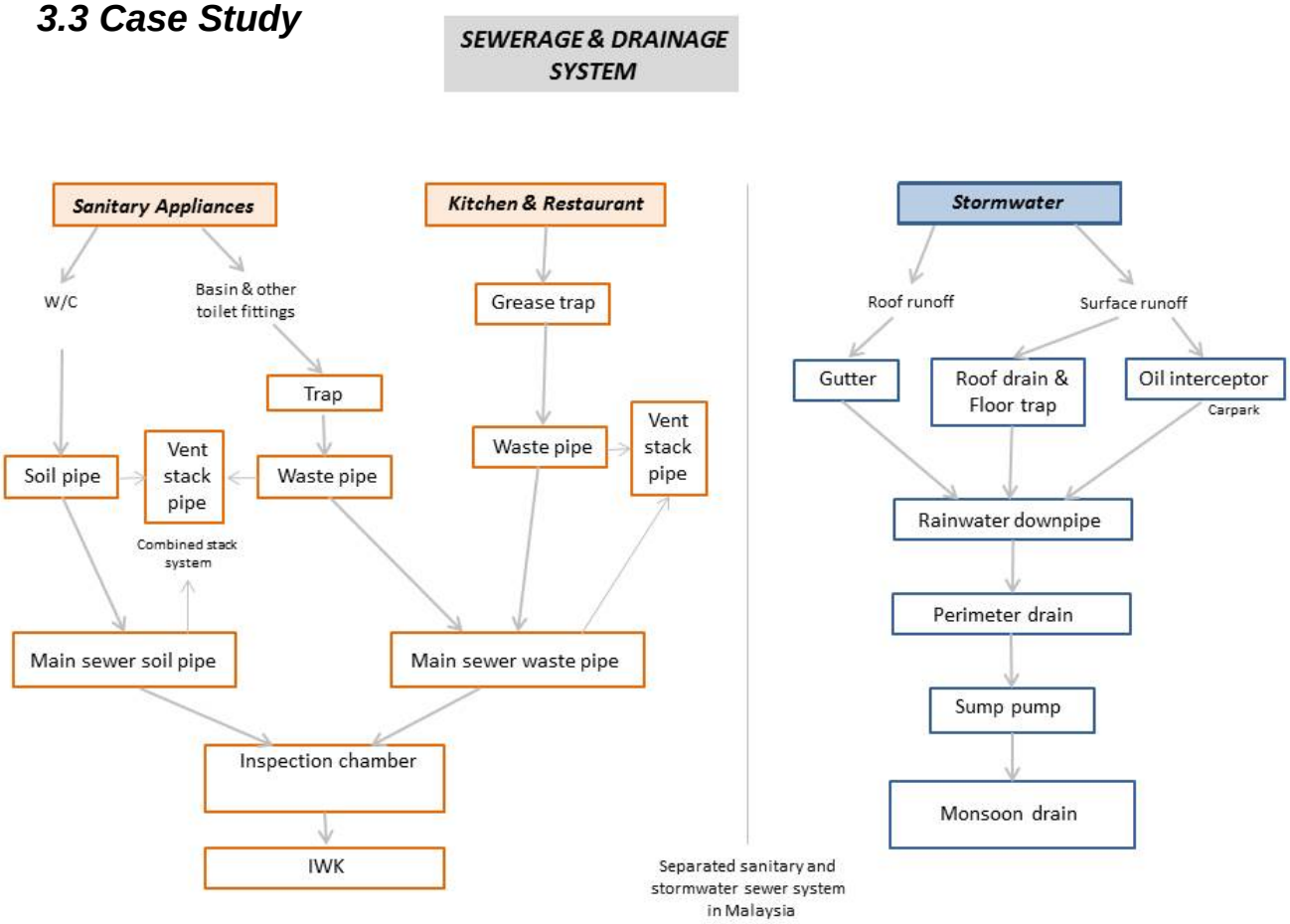


Figure 3.1: Diagram showing overview structure of sanitary sewerage system and stormwater drainage system of Setia City Mall.

3.3.1 Sanitary Sewerage System

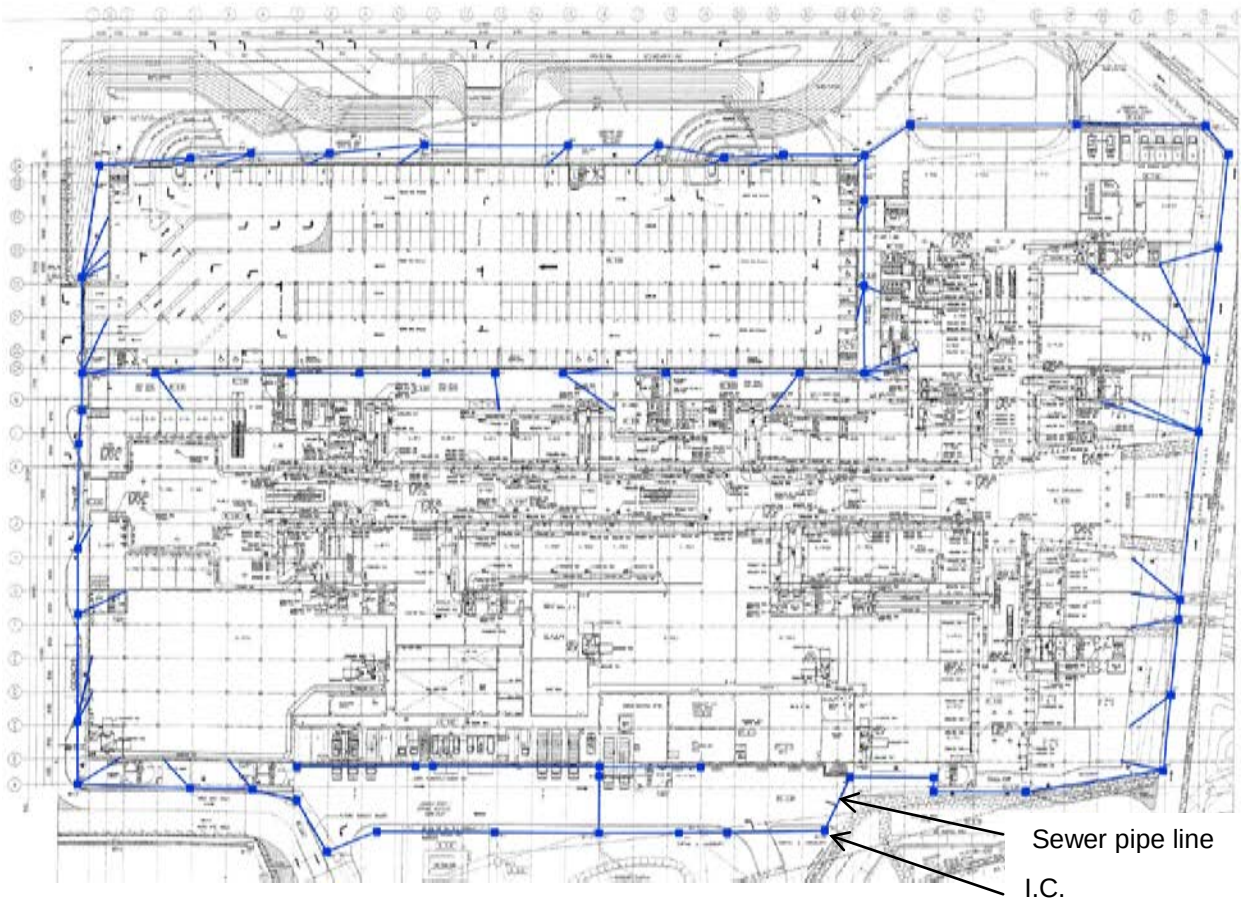


Figure 3.2: Sewerage piping network of Setia City Mall.

According to building routine maintenance schedule of Setia City Mall, inspection and rectification on toilet fittings, architectural finishes and other building components are scheduled daily; whereas inspection on functionality of grease interceptors, sump pumps and oil interceptors is done weekly by technician.

Laws of Malaysia

ACT 508 SEWERAGE SERVICES ACT 1993

Clearing, cleansing and emptying public sewerage system

Section 16.

The Director General shall cause public sewerage systems to be properly cleared, cleansed and emptied and, for the purpose of clearing, cleansing and emptying the public sewerage systems, he may construct and place, either above or underground, such reservoirs, sluices, engines and other works as are necessary.

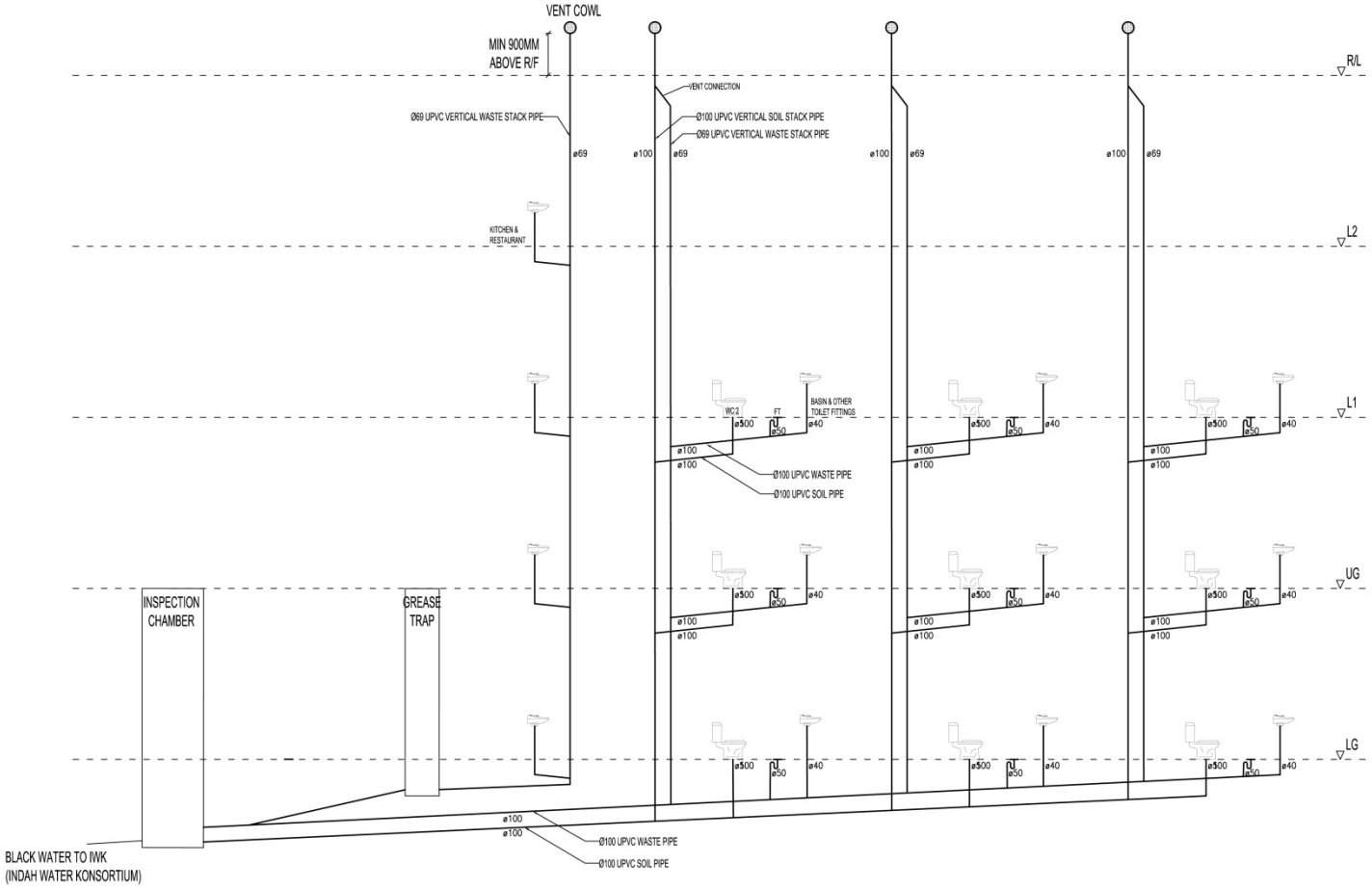


Figure 3.3: Schematic sanitary sewerage system of Setia City Mall.

As Setia City Mall serves as a commercial complex which consists mainly of restaurants and café, wastewater from these restaurants and other commercial food service facilities has separate pipe line from the main sanitary sewerage system, as shown in Fig 3.1. The higher levels of oil, grease and foods which could cause a higher biochemical oxygen demand is reduced in the main sewer lines by having grease trap. On the other hand, wastewater from washrooms is discharged from three main points of each floor except Level 2 (Fig. 3.1.2). All wastewater is then flows to main sewer pipes before passing inspection chamber and discharged to Indah Water Consortium.

3.3.1.1 Sanitary Appliance

Figure 3.4: Sanitary appliances of Setia City Mall: water closet, urinal, basin, tap (from left to right)

Figure 3.5: Locations of washroom are highlighted in red in Level 1 floor plan.

Toilet fittings equipped in Setia City Mall are mainly water-saving to prevent water wastages. These sanitary appliances can be classified into soil sanitary appliance and waste sanitary appliance. Examples of soil sanitary appliances are water closet pan, urinal and bidet etc; whereas examples of waste sanitary appliances are sink, basin and bath etc. As shown in Fig 3.3, wastewater from these two categorized appliances flow into soil pipe and waste pipe respectively.

Analysis

The connection of soil sanitary in Setia City Mall has shown at least one trap with a water seal of not less than 55 mm before connecting directly to a separate branch drain-line to an inspection chamber on first storey level or to a discharge pipe on upper level. For waste sanitary appliance, waste fitting trap is provided for connection to the waste pipe.

3.3.1.2 Trap

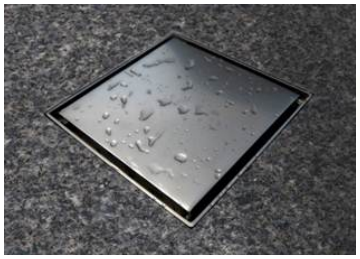


Figure 3.6: Stainless steel floor trap

Figure 3.7: Stainless steel bottle trap below sink

Figure 3.8: S trap of watercloset, ø110mm

Appliance	Trap/waste nominal bore (mm)	Trap seal (mm)
Basin	32	75
Bidet	32	75
Sink	40	75
Urinal bowl	40	75
Food waste disposal unit	40	75
WC pan	100	50

Table 3.1:Sanitation trap and waste data based on sanitary appliances equipped in Setia City Mall. (Greeno, 2006)

To prevent the ingress or foul air from the drain and sewer, sanitary fittings have to be fitted with water seal or trap. There are trap variation for different appliances used. (Fig. 3.6, Fig.3.7 & Fig 3.8) Most of the appliances incorporated with detachable access or a cleaning eye, except WC pan, which should be removable.

Analysis

Aluminium and stainless steel are chosen as material for traps, including floor trap and bottle trap for sink. Undoubtedly its aesthetic value has brought to the attention of this choice. Other than the visual appearance, it chemically provides corrosion resistance and at the same time offers high quality in physical. However, maintenance could be a main issue adopting this material in wet area especially washroom as aluminium needs remarkably high attention in cleaning works. Also, it can pick up rust if surface treatment is not properly done. Floor traps in Setia City Mall have properly installed to receive connection from waste appliances before discharging into branch drain –line, which has a a minimum water seal of 50mm for exclusion of foul air from the sanitary drainage system. Observation has made that the floor trap provided did not exceed maximum of 600mm, in order to facilitate maintenance, else a sump may have to be provided for deeper floor trap.

3.3.1.3 *Grease trap*

Figure 3.9: Locations of food and beverages retailer are marked with red in lower ground floor plan.

More than 80% of the food and beverages retailers are located at lower ground floor, which are highlighted in Figure 3.9. As there are very large amounts of oil from food production in kitchens and restaurants of these retailers, grease trapsare used to reduce the amount of fats, oils and greases (FOGs) that enter the main sewers. According to National Model Plumbing Codes, the standard requires grease interceptors to remove a minimum of 90% of the incoming FOGS.

Figure 3.10: Exterior view of grease trap located underground.

Figure 3.11: Grease floats on water surface in grease trap.

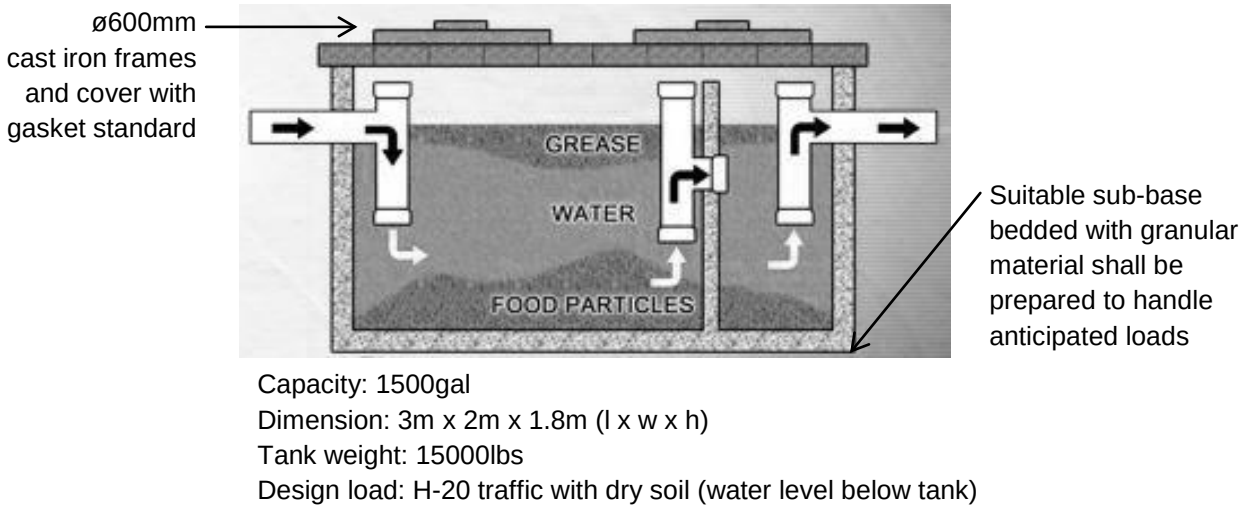


Figure 3.12: Cross section of typical concrete underground grease trap
(Source: Pioneer Liquid Transport, 2011)

The grease trap works by separation the grease from the water.When the outflow from the kitchen sink enters the grease trap, The greasy wastewater passes through a vented flow control that regulates the flow of wastewater. The slowed-down flow through a series of baffles allow enough detention time for separation where the solid food particles sink to the bottom while the lighter grease and oil floats to the top. The relatively grease-free water is then fed into the sewer system. The food solids at the bottom and floating oil and grease must be periodically removed.

Analysis

Large in-ground concrete grease tanks are used. This type of traps is generally gravity interceptor which requires 30-minute retention time for fats, oils, grease and food solids to settle. The weekly cleaning schedule of grease trap in Setia City Mall has ensured the rotting brown grease from food particles do not exceed 25% full.

3.3.1.4 Sewer pipe

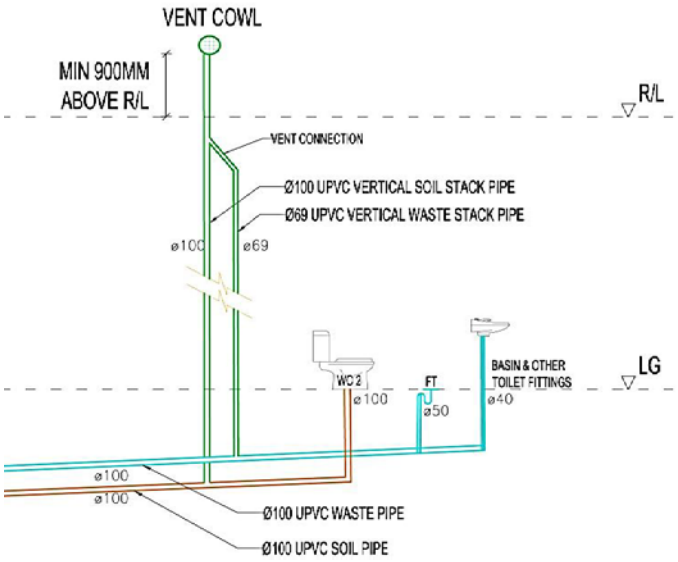


Figure 3.13: Schematic sanitary sewer system of lower ground floor showing wastepipe, soil pipe and stack pipe.

Unplasticized polyvinyl chloride (uPVC) is used as material for waste pipe, soil pipe and stack pipe in sanitary sewer system. (Fig. 3.13) This material gives a rigid pipe which is suitable for temperatures up to 20^{o}C. It is also widely used for cold-water supply and particularly for water mains, as discussed in 2.0. However, cast iron material is used for waste pipe accommodating wastewater from restaurant channelled to grease trap. (Fig. 3.14) In standard design considerations, the minimum size of pumping main shall be 100mm diameter whereas the minimum and maximum velocities in pumping mains shall be 1.0m/sec and 2.4m/sec respectively.

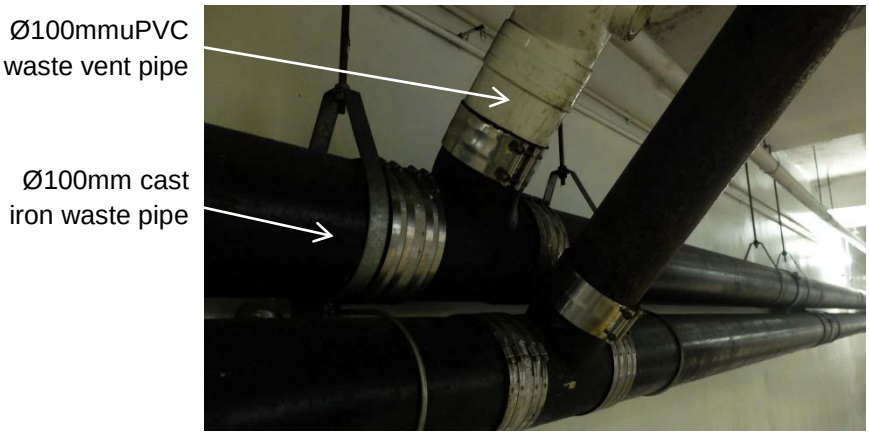


Figure 3.14: Cast iron waste pipe connecting from restaurant to grease trap.

Analysis

UPVC pipe is used mainly in the system as it offers a lower material cost for economy construction. However, cast iron pipe is used as waste pipe locally discharging wastewater from restaurants. Considering piping in these fire-prone areas, choice of material using cast iron pipe has overcome this issue. Generally, its fire resistance is relatively high than uPVC pipe because of its non-combustible characteristic. It will neither support a fire or burn away, leaving a hole through which smoke and flames can rush through a building. Another important feature is its low coefficient of expansion and contraction. As sewerage from cooking might involves wastewater of high temperature, cast iron can resist this sudden of temperature well. Thomas (n.d.) outlines that it expands and contracts at about the same rate as concrete and steel, approximately 1/4 inch per fifty feet within a 70 degree temperature change, contrasted to plastic pipe, which will expand and contract 2.338 inches. Thus, no expansion joints are needed for cast iron piping systems. However, the joint between different materials as shown in Figure 3.14 has to be carefully done which transitioning material is need.

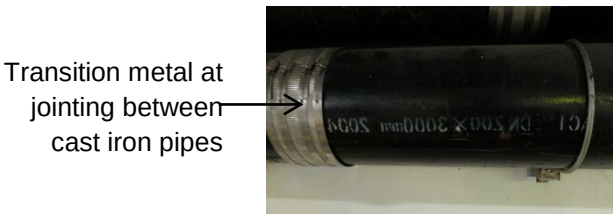


Figure 3.15: Cast iron pipe

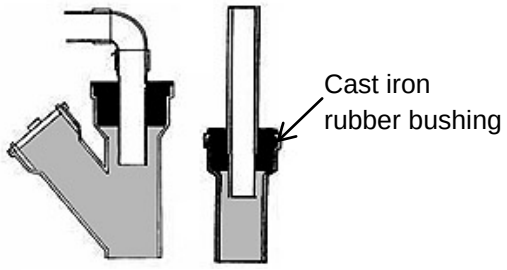


Figure 3.16: uPVC pipe to cast iron pipe joint.

Laws of Malaysia

ACT 133 Street, drainage and building ACT 1974

Rain-water pipes not to be used as soil-pipes.

Section 56.

No pipe used for the carrying off of rain water from any roof shall be used for the purpose of carrying off the soil or drainage from any privy or water-closet or any sullage water.

Water pipes, etc, not to be used as ventilating shafts.

Section 57.

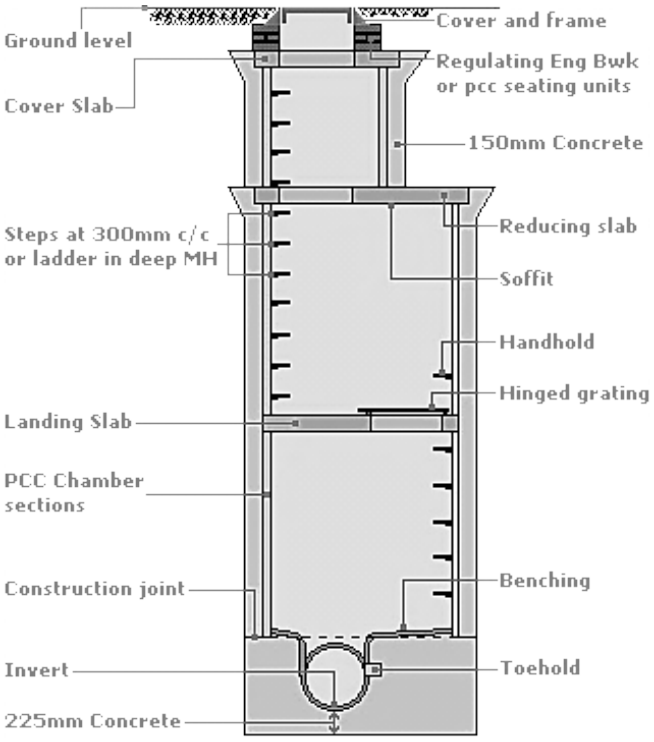
No water-pipe, stack-pipe or down spout usedfor conveying surface water from any premises shall be used or be permitted to serve or to act as a ventilating shaft to any drain or sewer.

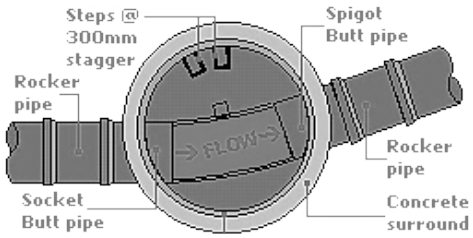
3.3.1.5 Inspection Chamber

Figure 3.17: Interior view of inspection chamber for sewer.

Figure 3.18: Cast iron cover 600mm x 600mm

Inspection chamber (IC) in sewerage system is the top opening to an underground utility vault used to house an access point for merging of pipelines or performing maintenance and cleaning on underground.An inspection chamber could be also served for the other buried public utility and services including telephone, electricity, storm drains and gas. IC has to be constructed whenever there is a change in diameter, materials or gradient level of pipes. It is also needed intermediate for long pipeline. Based on Figure 3.2, it shows the placement of IC over Setia City Mall.





Minimum internal dimension: 600mm x 900mm
Minimum depth: 1.5m

Figure 3.19: Cross-section and plan view of concrete inspection chamber. (Source: Paving Expert, 2014)

Analysis

The inspection chambers in Setia City Mall are constructed using reinforced concrete. They are designed to be watertight to minimize the risk of blockage as well as facilitate maintenance. As the location is overlooking a 10.5 acre park and lake, the design concern focused on the high water table to prevent floatation in ground. Referring to Figure 3.2 for the placement of inspection chamber, it is noticed that the distance between two inspection chambers does not exceed 120m, which follows the standard design requirement. Furthermore, it is also remarked that heavy-duty cast iron frame and cover are used in driveway and car park area to withstand heavy load.

3.3.2 Stormwater Drainage System

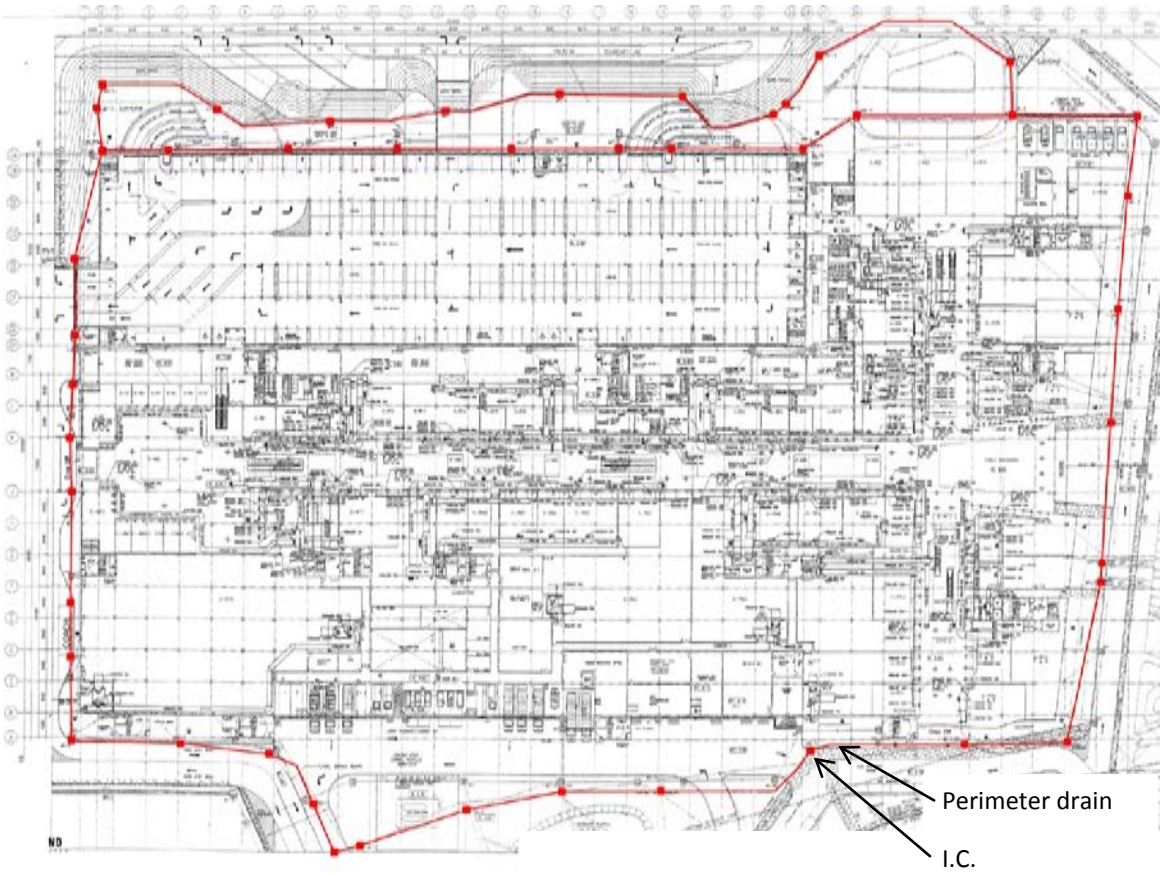


Figure 3.20: Stormwater drainage piping network of Setia City Mall.

Laws of Malaysia

ACT 133 Street, drainage and building ACT 1974

Cleansing and emptying surface and storm water drains, etc

Section 54.

(1) The local authority shall cause the surface and storm water drains, culverts, gutters and water courses under the control of the local authority to be so constructed, maintained and kept as not to be a nuisance or injurious to health and to be properly cleared, cleansed and emptied and, for the purpose of flushing, cleansing and emptying the same, it may construct and place, either above or underground, such reservoirs, sluices, engines and other works as are necessary.

3.3.2.1 Gutter and stormwater drainage pipe

Figure 3.21: Roof guttering on flat roof top

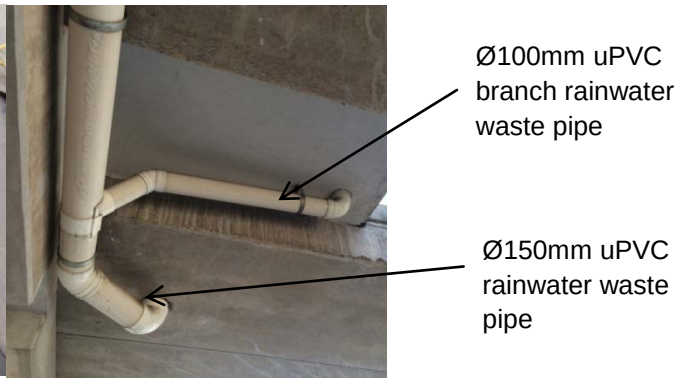


Figure 3.22: Stormwater drainage piping under roof structure.

The stormwater drainage system includes downpipes to collect rainwater from roof gutters and a network of pipes to collect and transport stormwater to the nearest discharge area. Piping in stormwater drainage system shall convey only wastewater from within the building and it is separated from sanitary piping to the sewerage system. Bends or kinks are to be avoided in any branch or main drain-line to facilitate the flow of wastewater as well as to ease maintenance works. Practically, the branch and main stormwater drain-line shall be laid using the same material throughout its entire length. In addition, the choice of gradient for the branch/main drain-line shall be such as to maintain self-cleansing velocity (0.9 m/sec) and not to exceed scouring velocity (2.4 m/sec) under normal discharge condition.

Analysis

Setia City Mall depends mainly on surface runoff through roof drain and floor trap rather than roof runoff through guttering. It is due to the presence of flat roofs with large surface area. As the roof area is relatively large, sufficient drainage system must be provided at intervals to accommodate the rain flow capacity, but not solely depending on the guttering at sides or perimeter of the roof. The branch drain-line installed has a minimum diameter of 100mm which its length does not exceed 10m. It is also noticed that the rainwater drainage system has separate piping system from sanitary drainage system so that wastewater fromthese two systems does not mix to ease wastewater treatment process.

3.3.2.2Oil Interceptor

Dimension: (L) 1.8m x (W) 0.5m x (H) 0.8m
Capacity: 50L/min
Body material: Fiberglass

Figure 3.23: Corrugate inclined oil interceptor (Source: Mawis SDN BHD, 2012)

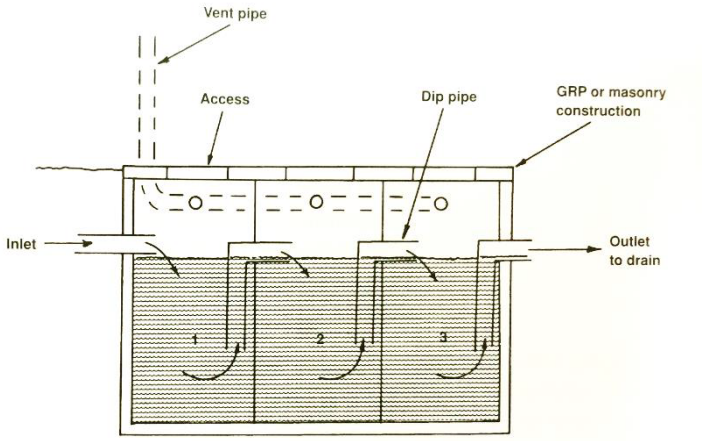


Figure 3.24: Oil interceptor operating principles. (Source: Greeno, 2006)

Oil interceptor is a treatment fitted for surface run-off from low risk areas such as roofs, car parks, and non-operational areas to protect the environment from pollution by oils. They separate the oil from the water, and then retain the oil safely until it is removed. They are installed to contain oil leaks from vehicles and plant and accidental spillages. To be effective, oil separators need to be correctly designed, installed and maintained. During emptying or maintenance, the separator should be isolated to prevent the escape of waste oil. The isolation valves are then opened when the operation is complete.

Analysis

As the car park in Setia City mall is partially exposed to rain and subject to surface water runoffs from rain, the drainage system serving the car park areas is connected to surface stormwater drain via oil interceptor. It is a must to be installed as the car park is larger than 800m^2 or more than 50 car parking spaces.

3.3.2.3Sump Pump

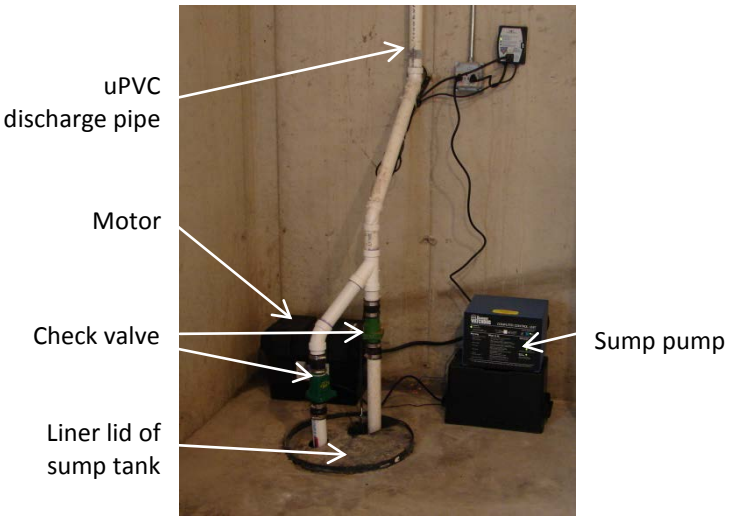


Figure 3.25: Components of sump pump.

Sump pump system is necessary for any commercial building with a basement where water table is above the foundation of a building. The water may enter through perimeter drains of a basement waterproofing system and it is removed away from the building to control water table problems in surface soil. A typical commercial or municipal storm-water pump station can be equipped with two, three or more non-automatic sump pumps. Often, these pumps are installed “in series” so scheduled maintenance on one doesn’t take the entire pumping station offline. It also allows building managers to bring additional pumps online during times of severe rainfall to increase the pump station’s capacity.

Figure 2.26: Duplex wall-mounted control panel (Source: Bates, n.d.)

“Commercial or industrial sump pumps may require 3-phase power in 208, 230 and 460 volts,” Shawler (n.d.) warns. Commercial-grade sump pumps require a solid, balanced foundation; they’re never suspended from the ceiling or over the wet well.

Analysis

Floor-mounted self-priming pumps are used as this type of pump allows the entire pump assembly to rest above the wet-well in a clean, dry, accessible location. Thus, all pump maintenance and repair can be accomplished without the need to lift the pump, or remove the pump from the piping. It is observed that reflux and isolating valves are provided for the case of dewatering sump pump.

Laws of Malaysia

M.S.1489 Part 1: Hydrant System, Hose Reels and Foam Inlets

Wet Riser Sysytem

It should be complied with UBBL 1984, the by Laws 231, 232 and 24

A Sump Pump need to be considered for any special case of that wet riser pump eets to be located at the basement below the external drainage levels. This wet riser pump sets room also need to be naturally or mechanical ventilated with a necessary signage and to provide a CO^2 portable type of fire extinguisher for any case of fire.

3.4 Conclusion

Sewerage system must be functioning well as improper functioning can lead to pollution and contamination of various aspects of life. It is crucial in wastewater management as a protective meansfor the environment in a manner corresponding with public health and socio-economic concerns. Understanding the nature of wastewater is fundamental as its nature suggested whether primary, secondary and tertiary treatment will be carried out before final disposal. Regular maintenance must alsobe done to the existing sewerage system and appropriate design must be applied to the new sewerage systems to ensure the sewerage systems are in good condition.

4.0 Fire Protection System

4.1 Introduction

The main cause of death in fire breakdown is not the fire itself, but rather the smoke, which might spread, in the first few minutes. Smoke inhalation is fatal, while smoke itself might cause trouble when one is escaping to an exit. Hence fire protection systems in a building shall be functioning well to prevent fire spread and to diminish it, if possible, in the first few minutes after the fire breaks. Fire protection system is broken down into two components- active and passive fire protection system. The main aim of a fire protection system is to save the occupants in a case of fire breakdown, and to save the building along with the contents inside it as well. The discussion under this system includes the fire suppression system, alarm system, smoke management and fire resistance.

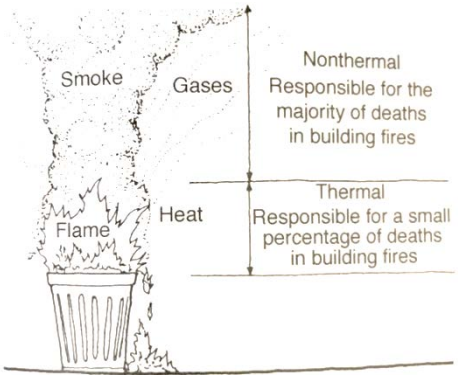


Figure 4.1: Although the flame and heat is what appeared to be the most fatal thing in a fire, it is smoke and other gases produced during the fire that has a greater threat of life. (Stein, n.d.)

4.2 Literature Review

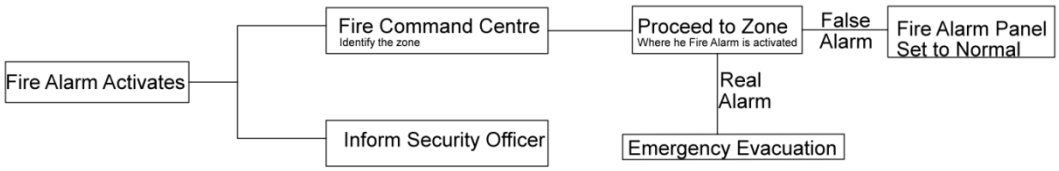


Figure 4.2: Maintenance emergency procedure in the case of fire alarm activation

Fire protection is divided into two major components: active and passive fire protection system.

4.2.1 Active Fire Protection System

Active Fire Protection System is an important part of the fire-fighting component in a building utilizing the action of moving parts, such as sprinklers and alarms. In the event of fire, it would be the first to react. There are three major categories of Active Fire Protection System:

1. **Fire Detection**
   When fire is detected, the next step is to make the occupants aware of the current situation, by means of audible and visible alarms. The detection of fire will lead to the next action by the motor components of the system.
2. **Fire Suppression**
   If the fire is still small and not categorized as dangerous, fire suppressing steps can be taken by the occupants in effort to extinguish the fire.

3. **Sprinkler System**
   A signal would trigger the sprinkler system to activate to release water or other agents to put out the fire.

4.2.2 Passive fire protection system

Passive fire protection system is another component in the fire fighting system in a building, which uses unmovable things to slow and/or contain fire. It is usually considered in the design stage of the building. It prevents the collapse by means of structural fire resistance, and when is properly installed can save lives and the building along with its contents itself.

Components of passive fire protection system:

- **Structural Fire Protection**
  The main purpose of structural fire protection is to guard the essential structural components like the structural steel and joint system. However, structure using steel might collapse when the critical temperature of 550°C is reached.

- **Compartmentation**
  In the case of fire, it is crucial that a building has the ability to divide itself into discrete fire zones, to separate between the fire zone and non-fire zone, and

also to limit the damage caused by the fire. It has the aim of delaying fire and smoke from spreading to other parts of the building before the arrival of fire fighters. Compartmentation is becoming a major issue in fire protection, as the contemporary design calls for design with less fire resistance and more open space which might cause fire to spead easily. Compartmentation used in Setia City Mall includes:

- **Opening Protection**

  If fire door and windows are to be installed in a fire barrier, it has to be fire resistance also in order to effectively stop smoke and fire from entering the space is inside the barrier. Glass used in the door and windows shall be tested for its ability to hinder fire. Fire and smoke dampers are used in the duct systems to prevent spread of fire through the air ducts which passes through the fire barrier.

- **Fire Stopping Materials**

  It is impossible for pipes of different types of services to not penetrate through fire barriers. Hence fire-stopping materials are used to limit the spread of fire via the gaps in between the penetrations in a fire barrier.

- **Fire Escape**

  Fire escape in Setia City Mall is mostly located inside the building, btu is separated from the main areas by fire rated doors and walls. It consists of horizontal platforms which leads to the stairs. In the case of fire, exit from the interior is provided through a fire exit door, and in some case through a window. Fire alarm should be installed on the door leading to the escape staircase, so that people are warned and the area is prevented for use other than to escape.

4.3 Case study

4.3.1 Active Fire Protection

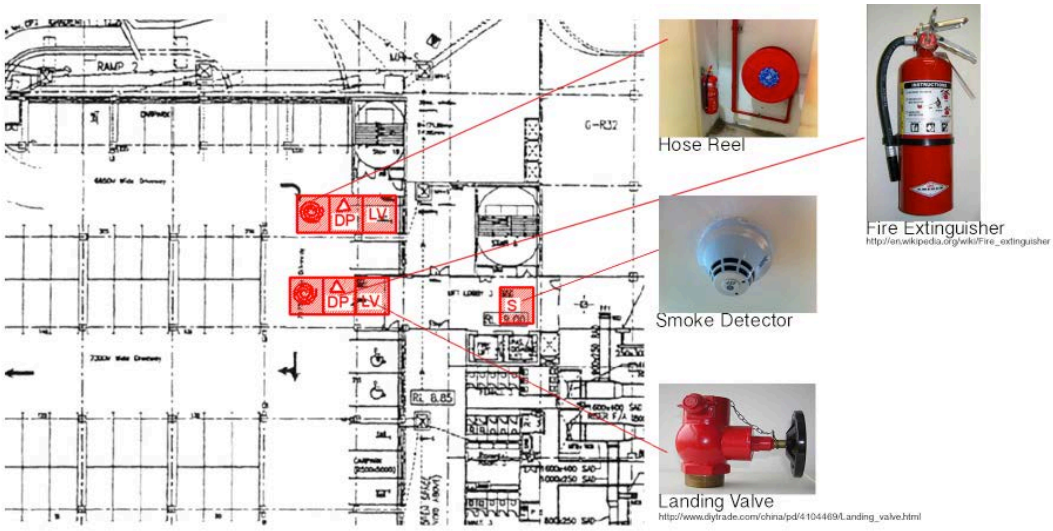


Figure 4.3: Placement of appliances involved in active fire protection system

4.3.1.1 Fire extinguisher

Fire extinguisher is used to extinguish small fires, which are not bigger than a waste bin. It is not meant for usage when the fire is already out-of-control, as it might cause danger to the user. The composition of the extinguisher varies, from water, foam, carbon dioxide to wet chemical. There are 4 main types of portable fire extinguisher, each with a distinct ability to handle fires. Appearance-wise, it can be distinguished by the labels, which indicate both the class of the extinguisher, and the size of fire it would be able to handle.

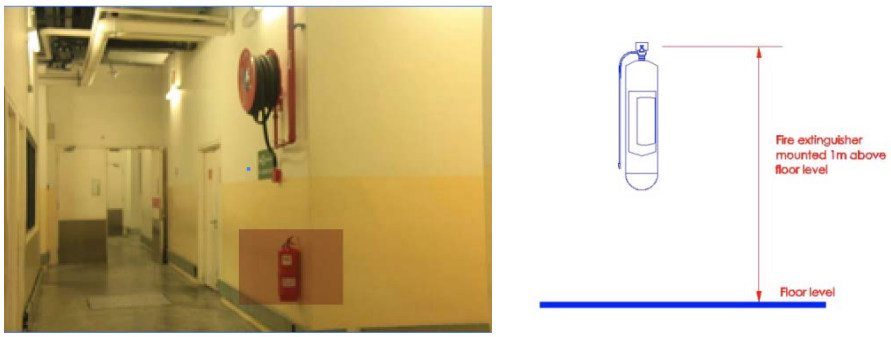


Figure 4.4: Class A Fire extinguisher in a hallway

Placed all around the building to extinguish small fires, which is not bigger than a rubbish bin. Different types of fire extinguisher use different agents.

Class	Function
A	Extinguish fire involving combustible solids like wood, cloth and paper
B	Extinguish fire involving liquids, greases and gases
C	Extinguish fire involving electrical equipment
D	Extinguish fire involving metals, like magnesium and sodium

Table 4.3: Classification and functions of fire extinguisher

UBBL 1984

Section 227

Portable extinguisher shall be provided relevant to the codes of practice and shall be located in prominent positions on the exit routes to be visible from every direction.

Analysis

Setia City Mall situated plenty of portable extinguisher along the corridors leading to the exit, and hence fulfill the requirement.

4.3.1.2 Sprinkler System

Setia City Mall has a wet sprinkler system, which discharges water immediately once activated. It consists of the least number of components and provides a lower chance of malfunction. It is easier to install and requires less maintenance when compared to dry sprinkler system, and can help to cut down cost. When modifications are needed, the system can be shut off by cutting the water supply. After being activated in a fire, wet sprinkler system has a relatively low down time, as it just needed the replacement of fused sprinklers and turning on the water supply again.

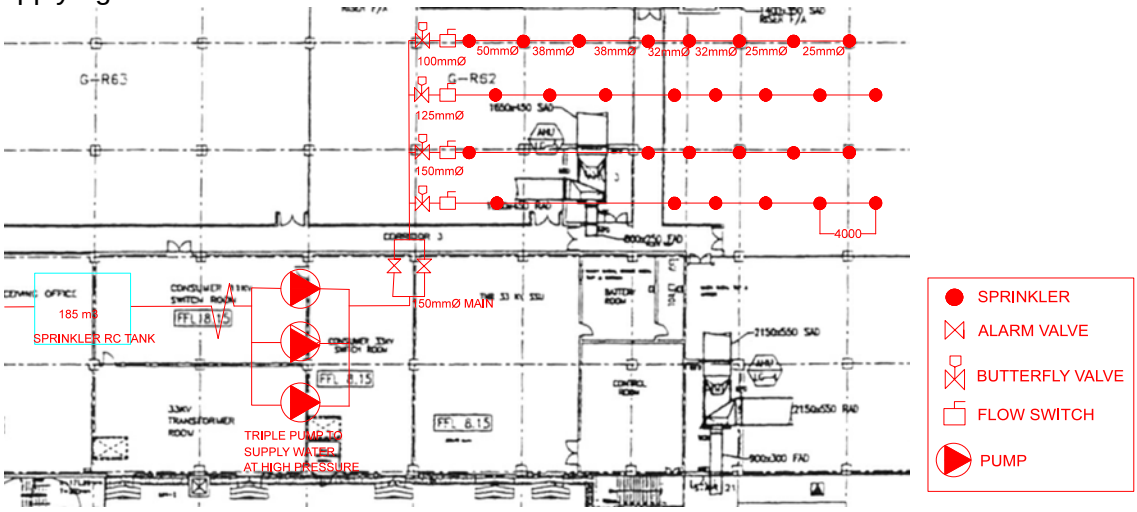
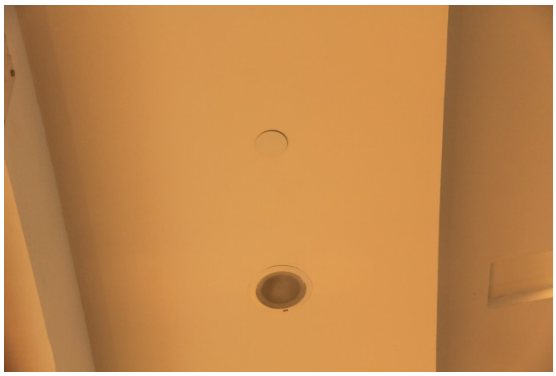


Figure 4.5: Distribution of sprinklers in a certain area in SetiaCity Mall.

Concealed Sprinkler

Setiacity Mall used special type of concealed sprinkler, which is connected to the pump room. There is a heat detector inside the sprinkler. When a temperature of above 58°C is detected, the sprinkler is activated and water is released to extinguish the fire.



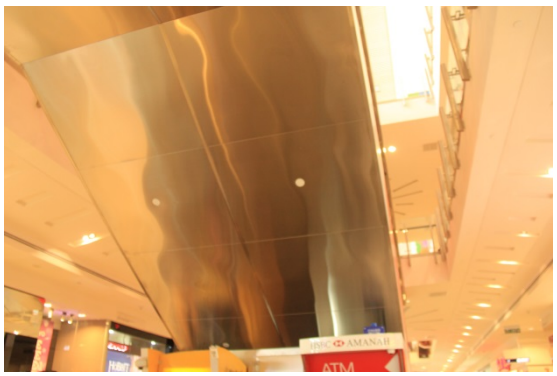


Figure 4.6: Concealed SprinklerFigure 4.7: Concealed sprinkler below elevators, to prevent fire to spread to the floors above

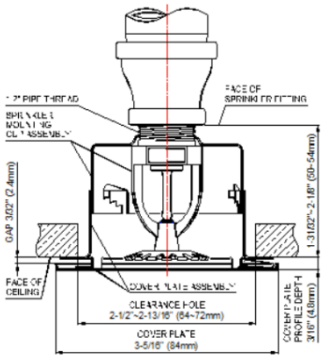


Figure 4.8: Components of Concealed Sprinkler

For the kitchens in the Food and Beverage shops the heat detector in the concealed sprinkler will only operate in a higher temperature, i.e. 73°C. This is because the temperature inside a kitchen is usually high.

4.3.1.3 Dry Riser System

Dry riser system consists of pipe work and valves that enables water to be delivered to all floors of the building. Dry riser method is used in building over 18 metres high, like Setia City Mall. Landing valves are fitted into the the vertical pipe as an outlet for the water. The valves are usually concealed by a cabinet and not exposed.

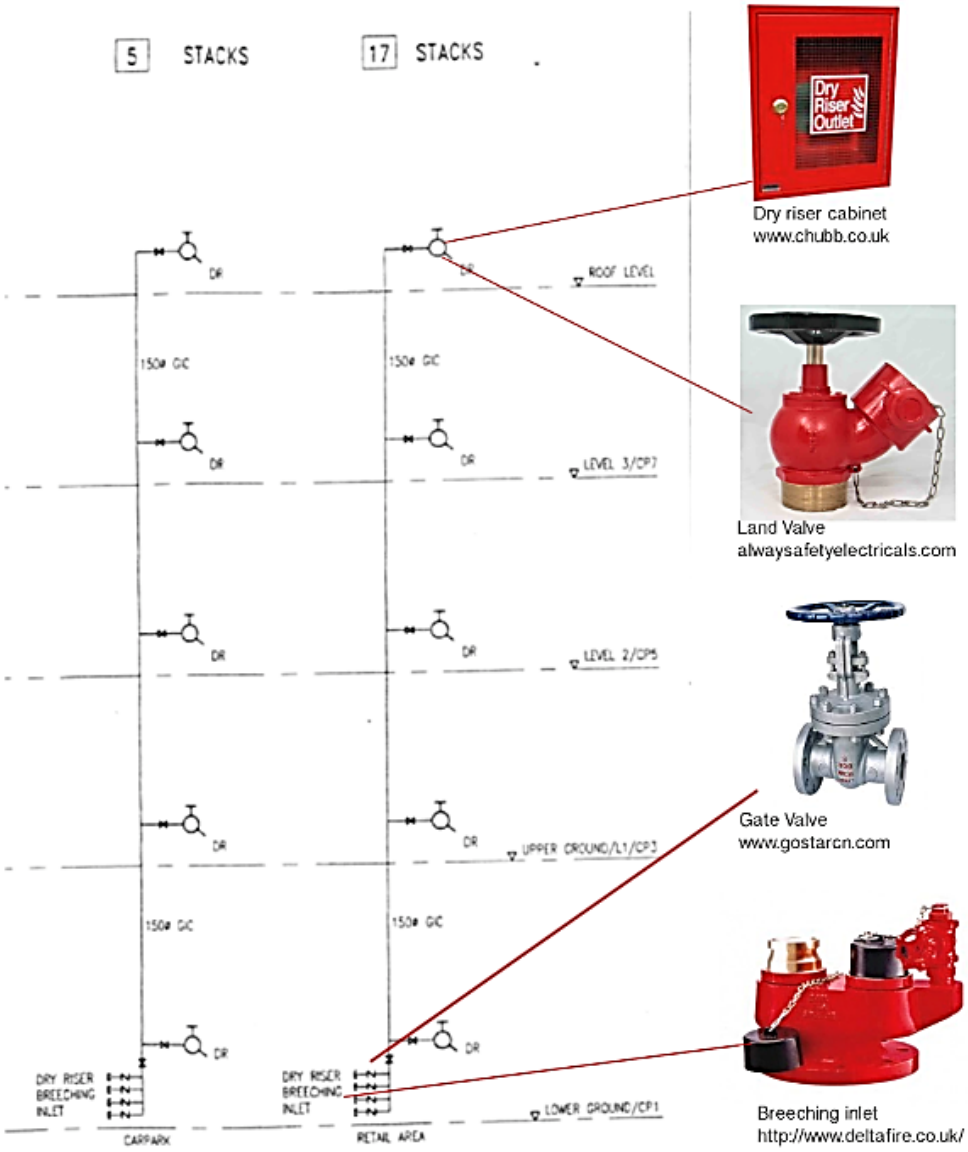


Figure 4.9: Dry riser system schematic diagram of Setia City Mal

UBBL 1984 Section 230
A hose connection shall be provided in each fire fighting access lobby. The dry riser shall be not less than 102 millimeters in diameter in buildings in which the highest outlet is 22.875m or less

Analysis

From the schematic in Figure 4.9, it can be seen that every floor is equipped with land valve to which hose can be connected. The pipe in the dry riser has a diameter of 150mm, hence it fulfills the requirement.

4.3.1.4 Smoke Detector

If the smoke detector inside the alarm is triggered, smoke curtain will be activated and shutter will go down to prevent fire from spreading (passive system). The alarm is triggered to warn the people inside the building to evacuate.

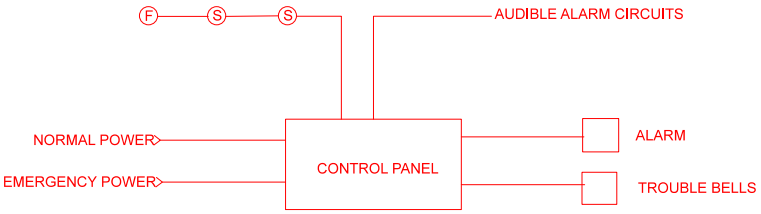


Figure 4.10: A simplified schematic diagram of a conventional fire alarm system

Figure 4.11: Smoke detector in front of a shop in Setia City Mall

In the case of a fire, fire alarm takes part in the most crucial part of the evacuation by alerting the people inside the building that there is a fire. Fire alarm can give out warnings by means of noise, light or both together.

4.3.1.5 Fire alarm

Fire alarm has the main purpose of protecting life and secondary purpose to prevent property loss. A fire alarm system has 3 major components: signal initiation, signal processing, and alarm indication. Signal initiation can be manual, like the break glass call points. Manual signal initiation shall be placed 1.4m above the floor level, and shall be visible. By breaking the glass, an alarm would be triggered. Automatic signal initiation means are also used. This includes the fire and smoke detectors and also water flow switches. Collected alarm signals are then processed by the equipment in the control panel (refer to Fig.4.14) to activate the audible and visible alarms, and also send signal to a central fire station.

Figure 4.12: Break glass call point

Figure 4.13: Fire buzzer

Audible alarm like fire buzzer shall have a minimum requirement of 15dBA, with the upper limit being 120dBA.

4.3.1.6 Argonite System

Fire extinguishing system that extinguishes fire by using gaseous agent instead of water is very crucial in spaces, which are prone to damage by water. This includes:

- Computer system room
- Document room
- Offices
- Galleries

In Setia City Mall, to overcome this issue Argonite is used.Argonite is a clean agent, consisting of 50% argon and 50% nitrogen. The system works like an automatic sprinkler. Argonite is used in the electricity room to protect the appliances. Water might damage the equipments, but argonite is a special agent, which is friendly and less fatal than CO_2.

Figure 4.14:Argonite Fire extinguishing system (Source: Mikare, n.d.)

Analysis

Setia City Mall used Argonite to eliminate the fatality which can be caused when CO_2 is used to suppress fire. Argonite is a very expensive chemical. Hence, from the choice taken by Setia City Mall it can be concluded that this mall is putting safety into its top consideration, putting aside other issues. Also, Argonite is completely safe for the environment, and adds up to the list of sustainable features which is emphasized by the mall.

4.3.1.7 Hose Reel

Figure 4.15(left): Schematic diagram showing the transfer of water to the hose reel

Figure 4.16(right): Fire hose reel concealed inside a cabinet

Water supplied to hose reel is not the same as the cold water supply system. Hence even though there is shortage of water the hose reel will still be functioning.

Outdoor Fire Hose

Outdoor fire hose cabinets shall be provided, to accommodate hose reel and nozzle. It is needed to fight fire that has already reached out soit does not spread any further.

Figure 4.17: A fire hose cabinet placed outside of Setia City Mall

4.3.1.8 Fire Tank Room

Fire water tank is different from the main water supply tank. This is to ensure that even when water supply is not available, the sprinklers and hose reel can still function properly. Fire tank room is located in the ground floor, alongside the pump room. In Setia City Mall, there are two separate tanks supplying the fire fighting components, namely the sprinkler water tank and the hose reel water tank.

UBBL 1984

Section 247

Main water storage tanks within the building, other than for hose reel systems shall be located at ground, first, or second basement levels, with fire brigade pumping inlet connections accessible to fire appliances

4.3.1.9 Pump room

Pump room is a space where the pumps required to move water to the fire fighting components are held in. The pump takes in water from the water tank (note that the water tank is different from the one in the cold water system) underground and supplies it, at high pressure to the sprinklers risers and hose standpipes. The pumps are usually powered by electric, diesel or steam

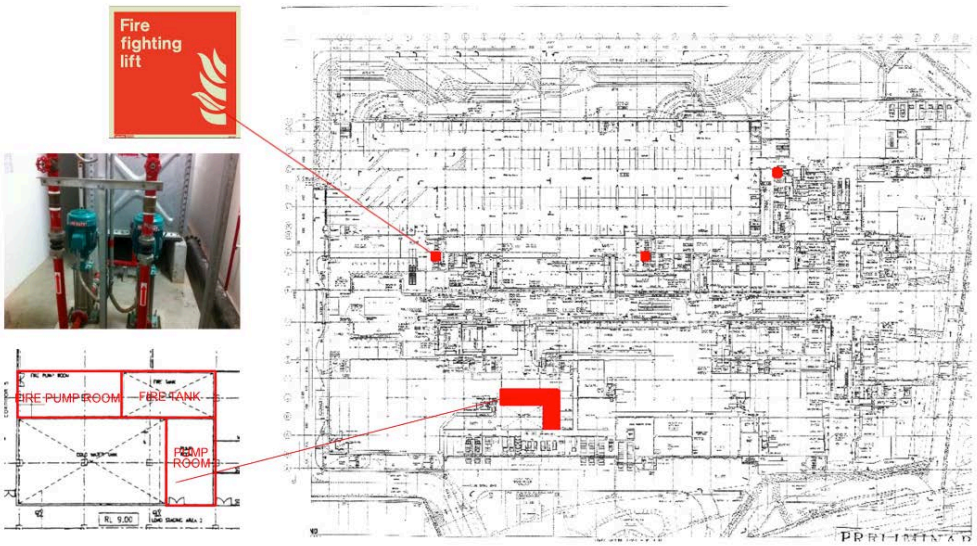


Figure 4.18: Placement of fire tank and pump room

4.3.1.9.1 Fire Pump

PUMP	PRESSURE
Jockey	100 Pa
Duty	85 Pa
Standby	70 Pa

Table 4.2: Pressure maintained in the different fire pumps in Setia City Mall

Figure 4.19: Pressure meter inside the pump room to control the pressure of the pumps

4.3.1.9.2 Jockey Pump

Figure 4.20: A jockey pump inside the fire pump room

Jockey pump has the purpose to prevent the system to go off randomly and also to prevent the damage of the sprinkler system. If lower pressure were detected, water would be pumped to replace the water in the system. It is important to replace water that is leaked out over time, as a decrease in pressure would trigger the sprinklers to go off. In the case of fire, the pressure drops significantly, and the jockey pump will not be able to keep up. Only then the sprinklers will go off. In the case of fire the presence of jockey pump prevents the pressure from dropping very low, which might damage the system when high pressure water sweeps through.

4.3.1.9.3 Duty Pump

Duty pump delivers water through the pipe system to the fire sprinklers to put down the fire. Duty pump, like any other fire pumps is powered by electric motor, steam turbine or diesel engine. If a twin electric fire pump is used, a secondary power source is needed. This can either be a generator on site, or an electricity sub-station. When rise in temperature is detected in the fire sprinkler, the pressure in the sprinkler system would drop below a certain point, and the pressure switch would send a signal to trigger the duty pump to start.

4.3.1.9.4 Standby Pump

If duty pump failed to operate after the trigger, a secondary pressure switch would cause the standby pump to start. In other words, standby pump is used as a backup for duty pump.

Figure 4.21: Duty pump (Source: Kurawak, n.d.) **Figure 4.22: Standby pump (Source: Naffco, n.d.)**

UBBL 1984 Section 226

Where hazardous processes, storage or occupancy are of such character as to require automatic sprinklers or other automatic extinguishing system, it shall be of a type and standard appropriate to extinguish fires in the hazardous materials stored or handled or for the safety of the occupants.

4.3.2Passive Fire Protection

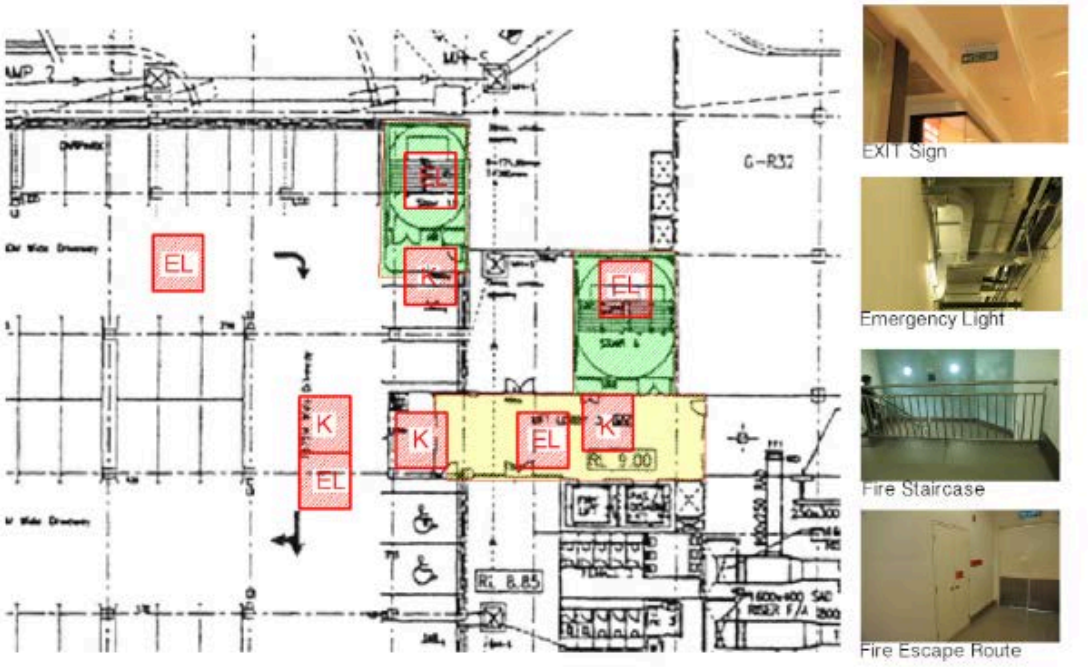


Figure 4.23: Some components of the passive fire protection system

4.3.2.1 Structural Fire Protection

InSetia City Mall, this type of protection includes:

-Usage of gypsum based plaster spray as fireproofing of steel beams and other structural components. By applying endothermic material like this plaster to the structure, will in turn make the structure possess fire resistance rating.

Figure 4.24: A worker spraying plaster to the beam to insulate it from a possible fire

Figure 4.25: Plaster insulation as seen in Setia City Mall

-Usage of cementitious products, for walls, ceilings and floor in some areas

- Usage of fireproof lightweight duct wrap to protect the ducts (Fig. 4.24), which usually gives up to 2 hours of fire resistance.

Figure 4.26: duct wrap used in a corridor in Setia City Mall

4.3.2.2 Compartmentation

4.3.2.2.1 Firewall

Firewall is a fireproof barrier, which is used to prevent fire from spreading through buildings or structures. It subdivides the building into separate fire areas.

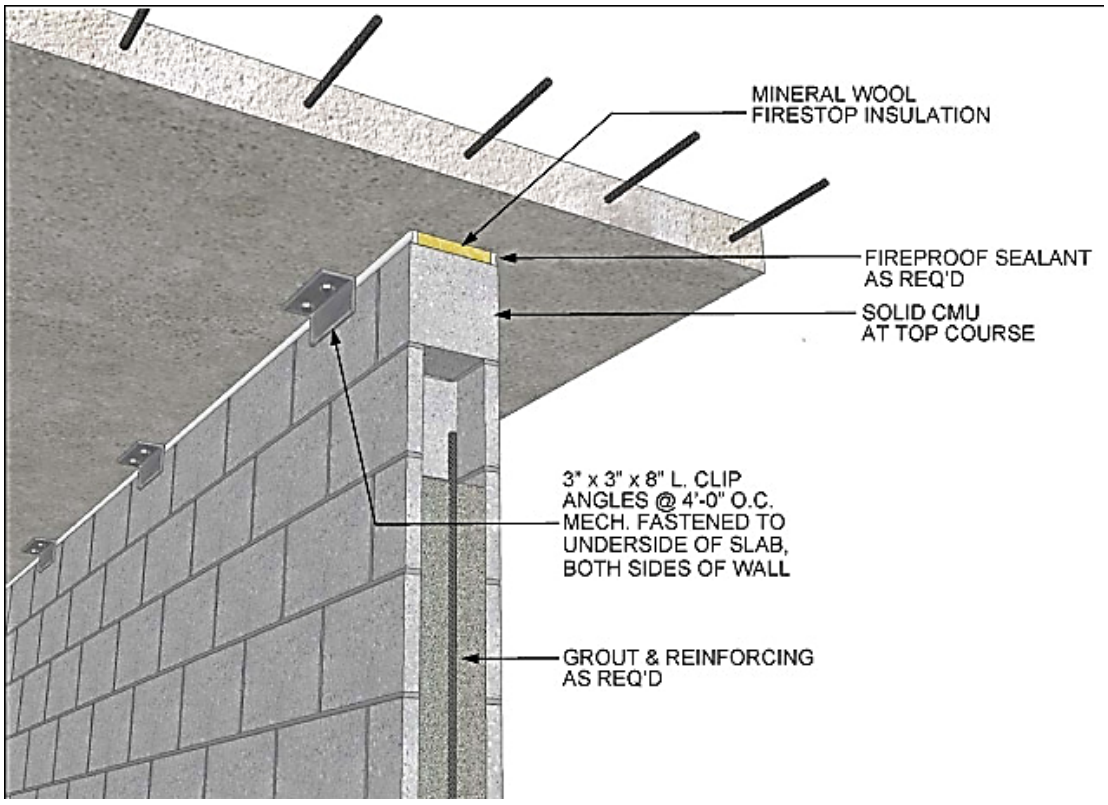


Figure 4.27: Components of concrete masonry firewall (Source: Imniwed, n.d.)

4.3.2.2.2 Smoke curtain

When the smoke detector detects smoke, it will activate the smoke curtain. It prevents the smoke from spreading to the other rooms or areas which might cause difficulties during evacuation. It is suitable for commercial buildings as it only falls during fire and hence is not causing obstruction.

Figure 4.28: Smoke curtain in the shop area of Setia City Mall.

4.3.2.2.3 Fire-rated Floor and Ceiling

The ceiling in Setia City Mall is suspended to buy more time for the fire resistance duration of the floor above.

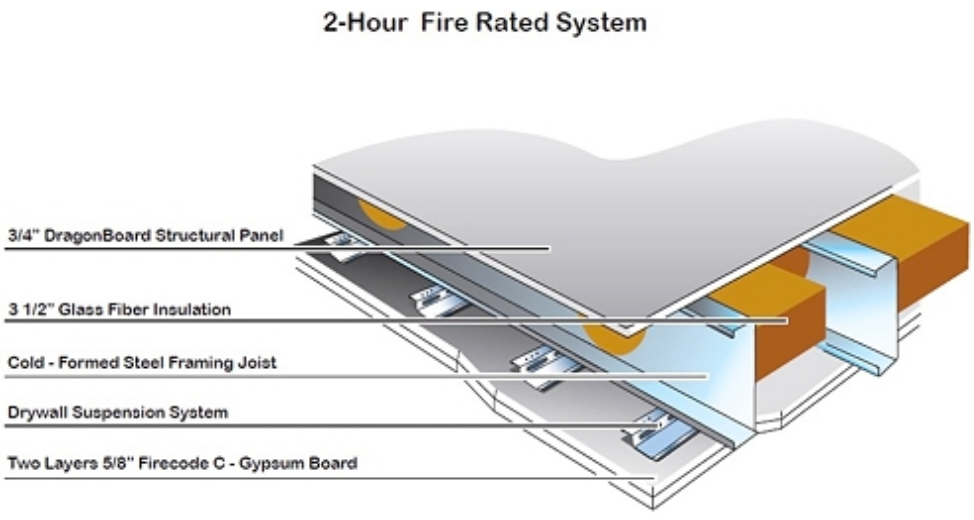


Figure 4.29: Components of fire rated floor (Source: Imperial Building Products, n.d.)

UBBL 1984 Section 139
Areas which are prone to fire breakdown shall be separated from the other areas by fire resisting construction of elements of structure of FRP which is to be determined by the local authority based on the degree of fire hazard.

4.3.2.3 Opening Protection

4.3.2.3.1Fire Door

Figure 4.30: Fire door leading to the fire staircase in Setia City Mall

Fire door is usually used in the fire escape staircases, to prevent fire from getting in. It has an automatic door closer such that in the event of evacuation the door will remain shut when no one is entering. It is also properly sealed to enclose the edges.

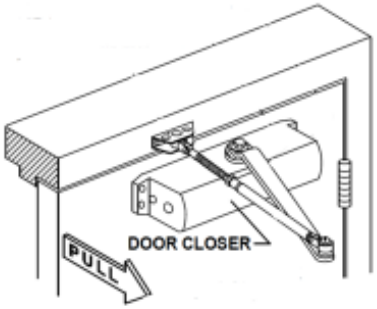


Figure: 4.31 Door Closures

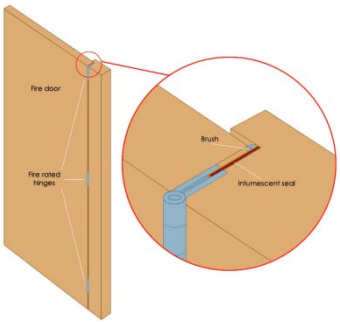


Figure: 4.32 Intumescent door seal

4.3.2.3.2 Closures

Closures or fire dampers are used to cover HVAC ducts in the case of fire, to prevent the spread of fire and smoke through the ductwork. It is operated when a rise in temperature cause a thermal element inside it to melt.

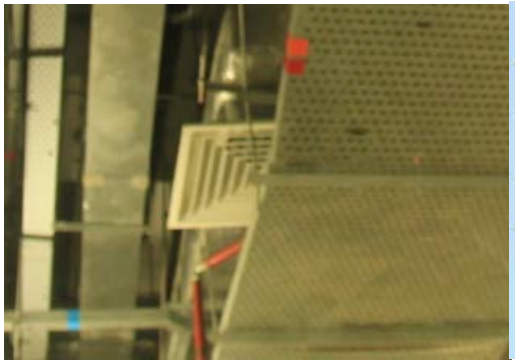


Figure 4.33: HVAC duct with damper installed inside.

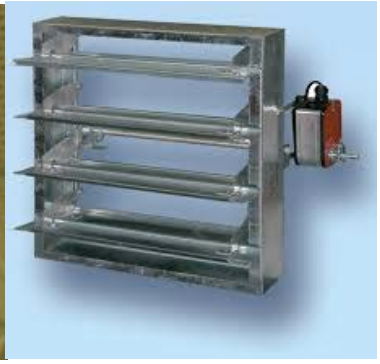


Figure 4.34: Fire damper(Source: Metal Press, n.d.)

4.3.2.4 Fire Stopping Materials

The materials, which can be considered as fire stopping components, include intumescent, cementitious materials, silicon, mineral fibre, etc.

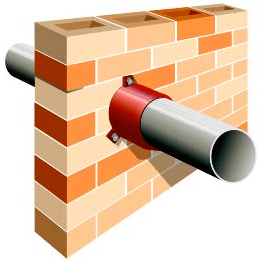


Figure 4.35: Through penetration firestop (Source: Intuchem, n.d.)

4.3.2.5 Fire escape

4.3.2.5.1 Horizontal escape

The main intention when designing a horizontal escape is to allow people to be able to turn away from it and make a safe escape in the case of fire outbreak. Hence, no obstacles shall be giving hindrance when evacuating. In the upper levels of the building, it shall be connected to the staircase leading to the ground level, where occupants can make their exit safely out of the building.

UBBL Section 167

Every compartment shall be provided with at least two storey exits located as far as practical from each other, in no case closer than 4.5 metres and in such that the travel distance does not exceed 45m (as is specified in the Seventh Schedule)

Analysis

The escape stairs in Setia City Mall are located around 70 m from each other at most. Hence, the maximum distance to travel to the nearest exit is way below 45m.

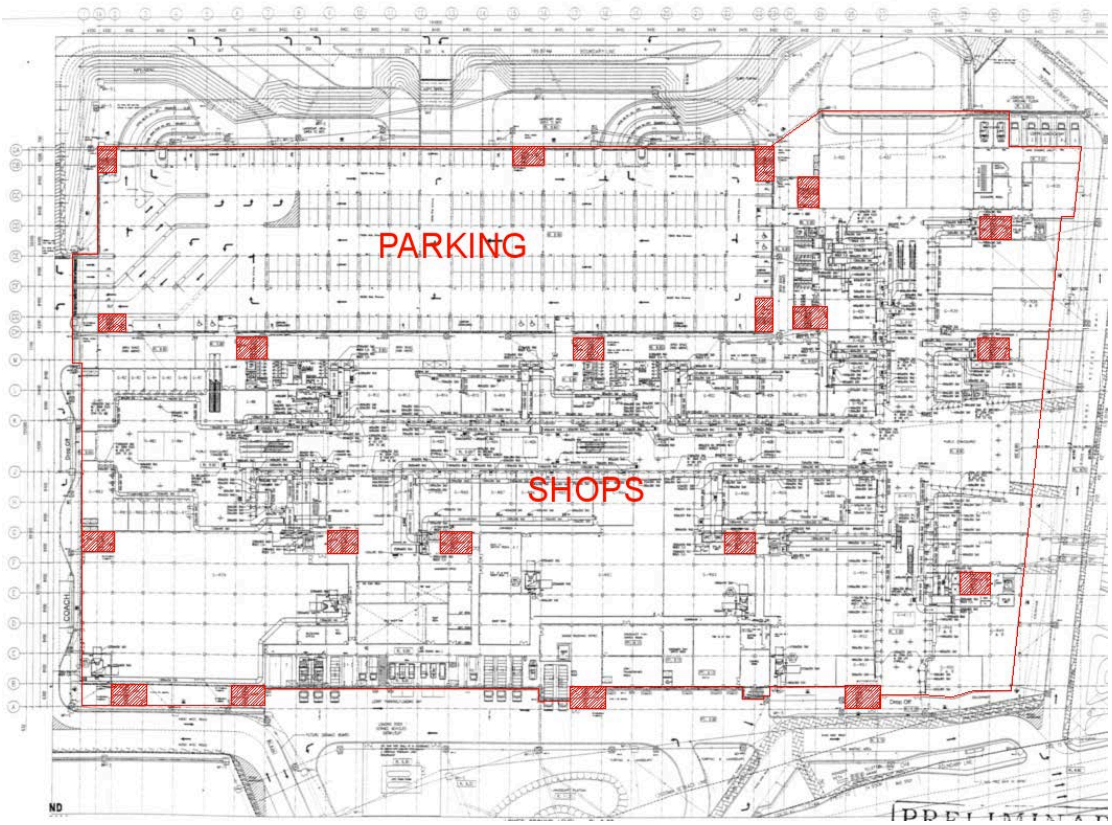


Figure 4.36: Shows the distribution of fire escape stairs (red)

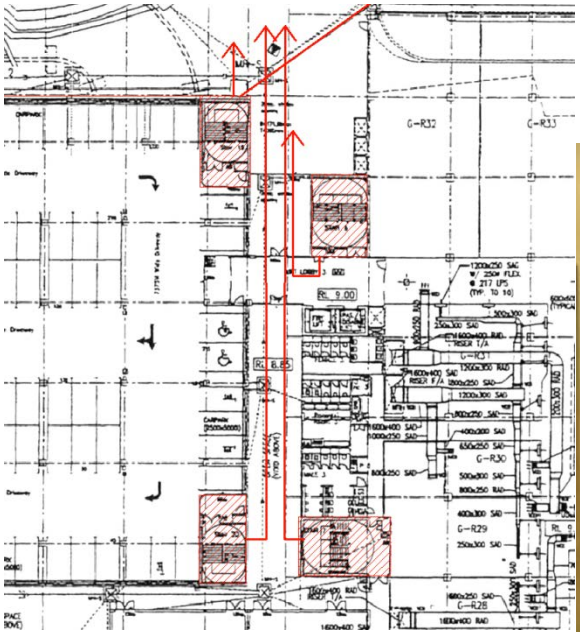
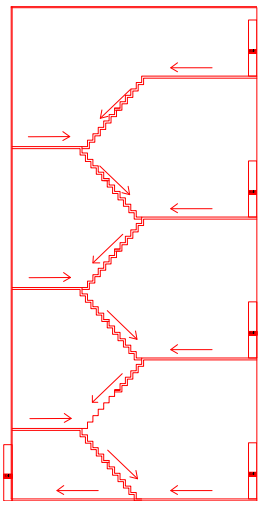


Figure 4.37: Exit route from storey exits

Figure 4.38: Storey Exit in Setia City Mall

4.3.2.5.2 Vertical escape

The most important aspect when providing escape route in a multi storey building is by means of sufficient number of escape stairs. It has the main purpose of allowing occupants to from the upper levels to get to the safe open air in the ground floor. The stairs shall be protected by fire resisting construction and be able to prevent fire from entering.



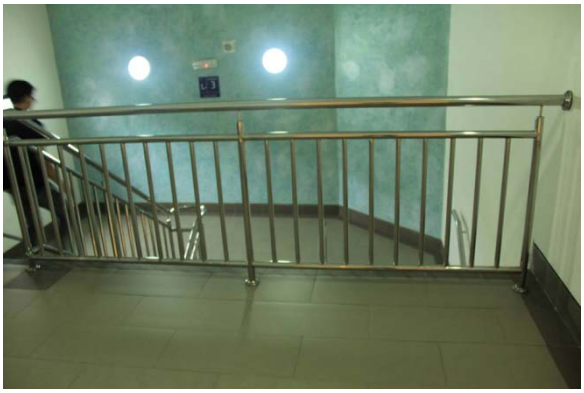


Figure 4.39: Vertical fire evacuation route

UBBL 1984

Section 168, regarding fire escape staircases.

Staircases shall have adequate width to accommodate the highest occupancy load. Doors accessing the staircases shall be positioned so as not to interfere the landing.

4.3.2.5.3 Lighting and Signs

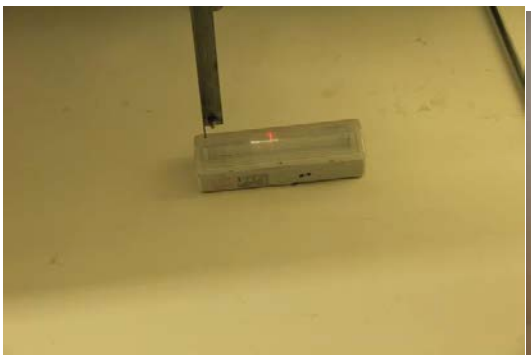


Figure 4.40 (left): Emergency light which would illuminate the escape route in case of emergency

Figure 4.41(right): Signboard leading to exits, coloured in bright

During a fire, it is most likely that the electricity supply will be cut. This will lead to failure of the normal lighting. When the electricity is loss, emergency light will immediately and automatically be switched on with high level of illumination to lead occupants to the exits. Emergency light is battery operated.

At the other hand, the exit sign shows the way to the nearest exit. It is designed so as to allow people to easily identify it without mistake. In almost every exit sign, a pictogram of a man running through a door is used, along with the 'EXIT' (or 'KELUAR' in Setia City Mall) word, all in capital and in white to make it clear from the bright green background of the board.

UBBL Section 172

(1) Storey exits and access to such exits shall be marked visible signs and shall not be obscured by any decorations, furnishings or other equipment.

(2) A sign reading "KELUAR" with an arrow indicating the direction shall be placed in every location where the direction of travel to reach the nearest exit is not immediately apparent.

Analysis

There are adequate escape stairs inside Setia City Mall, and the 'EXIT' signs are clearly visible from every direction. Emergency light can be found throughout the hallway too. The only concern is that, will the numerous amounts of escape routes be successful or would it end up in a chaotic manner. It shall be sufficient for its current condition that the mall is not very crowded because it is still new, but what if it gets to be overflowing with visitors in the future.

4.3.2.5.4 Fire lift

Fire fighting lift is powered by dual power supply, and can be operated by the Command Centre. When the firemen switch is operated, the lift will activate the firefighter mode. In this mode, the lift can only be controlled within the car, and hence the door will only open on the floor desired by the firefighter inside the car and not in between. However, fire, heat and water can cause the lift to fail, and the firefighters shall be anticipated to this.

Figure 4.42: Fire lifts in Setia City Mall marked red

UBBL 1984 Section 243
Fire lifts shall be provided in buildings where the top occupied floor is over 18.5 metresabpve the fire appliance access level.

Analysis

The height of Setia City Mall is around 18.5 metres, and is equipped with fire fighting lifts.

4.3.3 Others

4.3.3.1 Fire Fighter Direct Line

Figure 4.43: Direct line to the fire fighter HQ

The telephone which connects to the fire fighter is located inside the fire escape staircase, storey exits, lift motor room, fire pump room and command centre.

4.3.3.2 Fireman Switch

A specialized switch made of non flammable materials. It is usually located outside of shops. In case of fire, firemen would use this appliance to turn off neon lighting and electrical equipment to prevent overheated equipment from exploding.

Figure 4.44: (left) Fireman's switch (www.mkwheatingcontrols.co.uk)
Figure 4.45: (right) Central command centre

4.3.3.3 Central Command Centre

Setia City has a command room where security system is being monitored and managed 24 hours. The building is equipped with CCTV which covers the critical areas. The CCTV is monitored in the command centre, so that when an emergency breaks, actions can be taken immediately.

UBBL 1984

Section 238 – Command and control centre

Building exceeding 30.5 metres in height shall be provided with control centre in a designated floor, and shall b equipped with panels to monitor the waterfowl detectors, fire detection and alarm systems and with a direct telephone connection to the appropriate fire station by-passing the switchboard

4.4 Conclusion

Setia City Mall has its fire alarm system tested monthly after the business operation hours. It is crucial to make sure that the alarms are functioning properly so that the people inside the building are immediately informed when fire breaks. Fire extinguishers certificate and services for fire protection is checked annually. The appliances in Setia City Mall as seen during the site visit were new and up to standard. From observation and analysis, it is deduced that they had not only met the requirement, but also go slightly beyond to ensure safety. It can be concluded that Setia City Mall fulfills the fire protection requirements, and has a plus point of considering green movement.

5.0 Air Conditioning & Mechanical Ventilation System

5.1 Introduction

Air conditioner, a modern device that is often found in various buildings both huge buildings such as shopping places or small buildings such as houses. Air conditioner is a device that can control a space's temperature, humidity, air cleanliness and air movement and also heat radiation with mechanical means in order to achieve human comfort. Centralized air conditioning system is one of air conditioning system that is used in huge buildings.Some of the important components that play a role in this system are cooling tower, chiller and air handling unit (AHU). Air conditioning system is typically associated with mechanical ventilation system, becausemechanical ventilation system is a systems that control fresh air in the building. This system expel a stale air which is containing carbon dioxide, water vapor, airborne chemicals and other pollutants from the building and provide fresh air from outside of the building.

5.2. Literature Review

Air Conditioning is the control of the humidity of air by either increasing or decreasing its moisture content. Added to the control of the humidity is the control of temperature by either heating or cooling the air, the purification of the air by washing or filtering the air and the control of the air motion and ventilation.(*Willis H. Carrier*)

Thermal Comfort is necessary in maintaining the ideal temperature inside a building environment. According to ASHRAE Handbook, extracted from MS1525, a normal room comfort temperature is between 23 ^{o}C to 27 ^{o}C if mechanically cooled. Nevertheless mechanical cooling is essential in an occupied space, as it gives the feeling of freshness to the layer of skin as it lowers the temperature. Depending on the space, whether it is residential or commercial, mechanical cooling caters for all types of spaces. (*MS 1525:*2006*)*

Central plant system has one central source of conditioned air that is distributed in a network of ductwork. Thus, it is usually used in large buildings as the equipment is bulky. The room air-conditioning units are self-contained package, which are usually positioned in every room to provide cool air. Most air-conditioning system these days in Malaysia uses water-cooled system, which uses cooling tower. (*Hall*, 1976)

Buildings and large infrastructures such as malls generally have central air conditioning. A central air conditioning unit consists of major components like evaporator, compressor and condenser. The evaporator is attached to an air handling mechanism or a forced air furnace. The whole system is housed in a packaged unit or room that is often located outdoors, rooftops or basements. (*Peterson*, 2006)

Air Handling Unit rooms handle the all-air system. The purpose of having AHU is to supply constant airflow, draw in air from outside, filter the unwanted toxic substances (pollutants) and deliver the cool fresh air into the distribution system; ductwork and diffuser. (*Grondzik, Kwok, Stein & Reynolds, 2010)*

“The Fan Coil Units are smaller and self’s contained than the AHU. And the major difference between AHU and FCU lies in the fact that in FCU’s there is no ducting involved for the movement of air. In the FCU’s the fan in the internal section of FCU carries out the function of moving the air overheated or cooled coil and then directly moving out the air into the surrounding air without the use of any ducts.” (*Alec, 2009)*

“Without Mechanical ventilation to provide fresh air,moisture,odors, and other pollutants can build up inside a home.” (*Energy Star Agency, 2011*)

The purpose of this system is to control the air inside the building. This is because it is hard to achieve indoor air quality and natural ventilation if the building was situated in a polluted area. And this system can help the building to control the fresh air and expel the stale air to get out from the building.

5.3 Case Study

The type of the air conditioning system that Setia City Mall uses is “Centralized Air Conditioning system”. The components of centralized air conditioning system are:

1. Cooling Tower
2. Centrifugal chiller
3. Air Handling Unit (AHU)
4. Fan Coil Unit (FCU)

Mechanical ventilation components applied in Setia City Mall are:

1. Kitchen Exhaust Fan
2. Kitchen Make Up Fresh Air Fan
3. Smoke Make Up Fan
4. Smoke Extraction Fan
5. Pressurization Fan
6. Toilet Exhaust Fan
7. Fresh Air Fan

5.3.1 Air Conditioning System

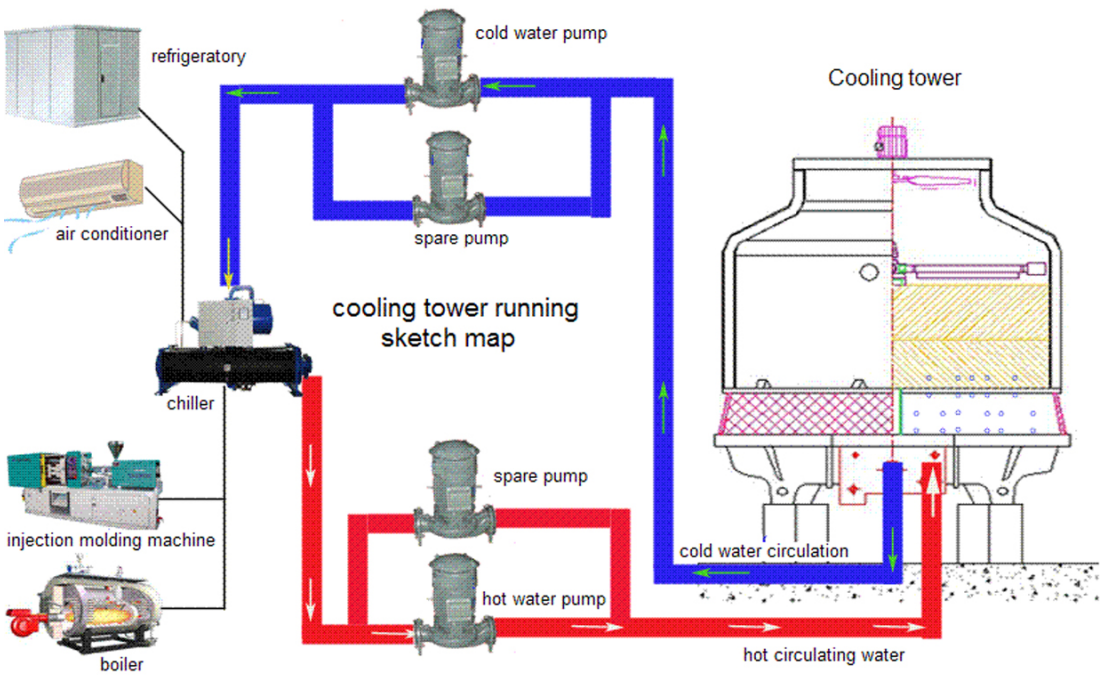
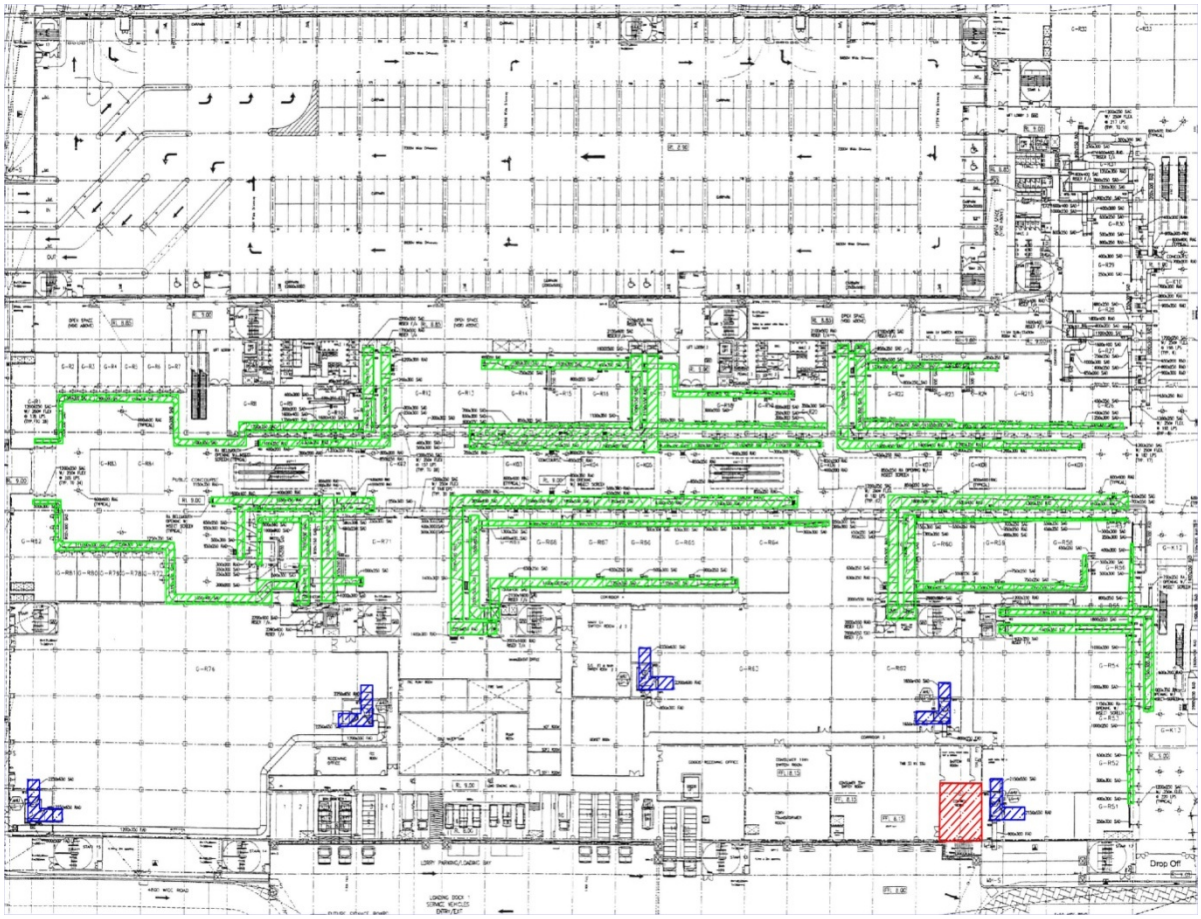


Figure 6.1: Diagrams showing function of centrifugal chiller and cooling tower installed in Setia City Mall.



Control Room

AHU (Air Handling Unit)

Ducting

Figure 6.2: Location of control room, air handling unit (AHU) and ducting of air conditioning system.

Laws of Malaysia

ACT 113 STREET, DRAINAGE AND BUILDING ACT 1974

SPACE, LIGHT AND VENTILATION

Section 41

(1) Where the permanent mechanical ventilation or air conditioning is intended, the relevant building by laws relating to natural ventilation, natural lightning and height of rooms may be waived at the discretion of the local authority.

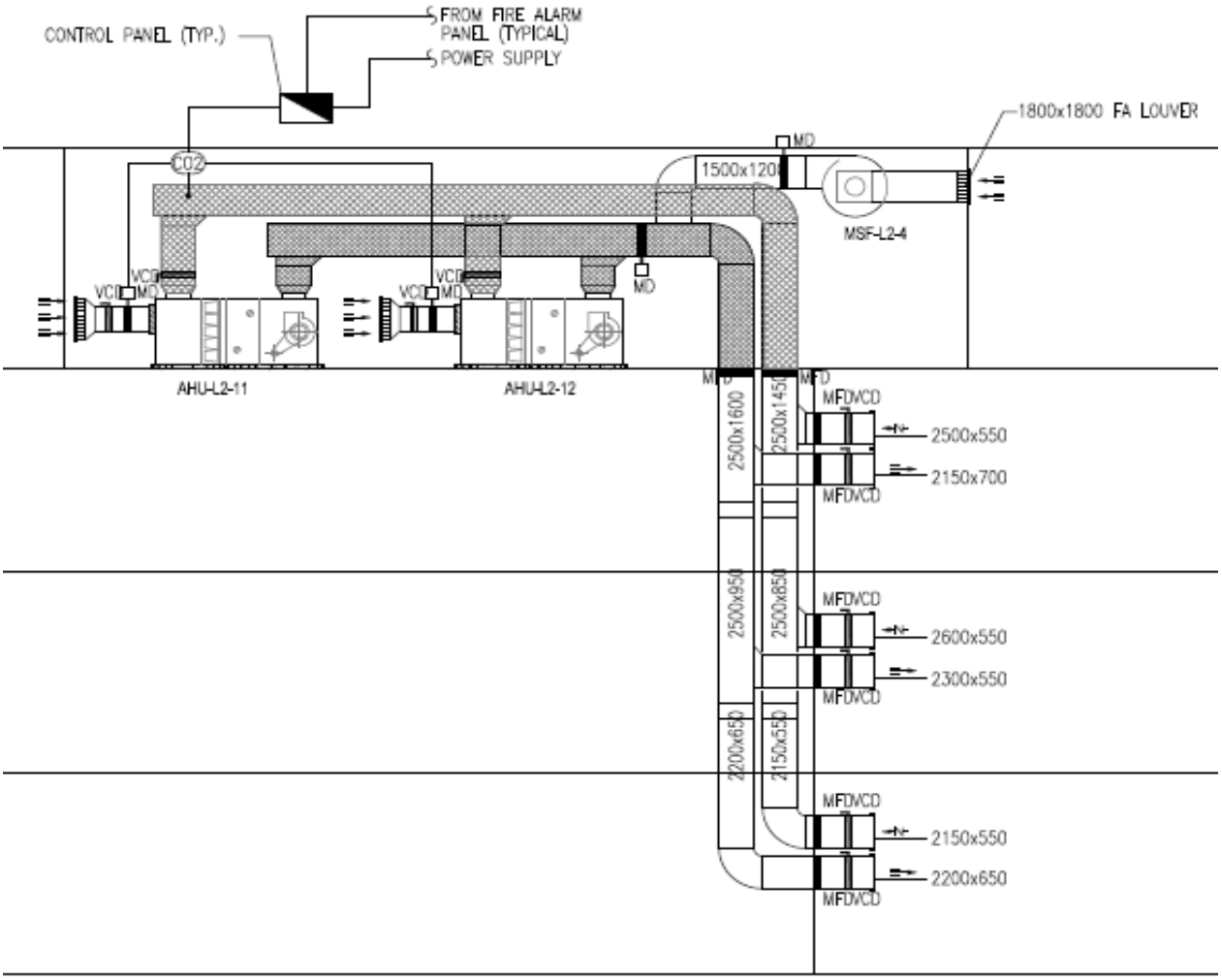


Figure 6.3: Schematic diagram of air conditioning and mechanical ventilation system in Setia City Mall.

Laws of Malaysia

ACT 113 STREET, DRAINAGE AND BUILDING ACT 1974

SPACE, LIGHT AND VENTILATION

Section 41

(2) Any application for the waiver of the relevant by-laws shall only be considered if in addition to the permanent air-conditioning system there is provided alternative approved means of ventilating the air-conditioned enclosure, such that within half an hour of the air conditioning system failing, not less than the stipulated volume of fresh air specified here in after shall be introduces into the enclosure during the period when the air-conditioning system is not functioning.

5.3.1.1 Cooling Tower

A holistic approach towards the design of the overall building system is undertaken to ensure that Setia City Mall can be an extremely energy sufficient commercial building. Cooling tower is a device that extracts heat out to the atmosphere from the hot water and cold water and will be sent back to the chiller, as shown in Figure 6.4. In Setia City Mall, a cooling tower with total capacity of 7000TR is utilized.

Figure 6.4: A picture of Cooling tower. (Source: Cooling tower. 2014).

Analysis

Beside the easy installation, cooling tower is an appropriate choice of Setia City mall because there are no more strainers or nozzle blocked for adequate temperature and recirculation of water. Moreover, it has higher energy transfer efficiency to clean the surface.

5.3.1.2 Centrifugal Chiller

A centrifugal chiller is a machine that is used to cool liquids by removing heat through the use of either vapour compression or a refrigeration cycle. The machine is used in a variety of ways including in air conditioning systems and the other industrial applications. In Setia City Mall, the centrifugal chiller that they use is a chiller with a total capacity of 5000TR. It were optimized with chiller installation of high COP of 6.4 for 1000RT chiller and COP of 5.9 for 500RT chiller installed.

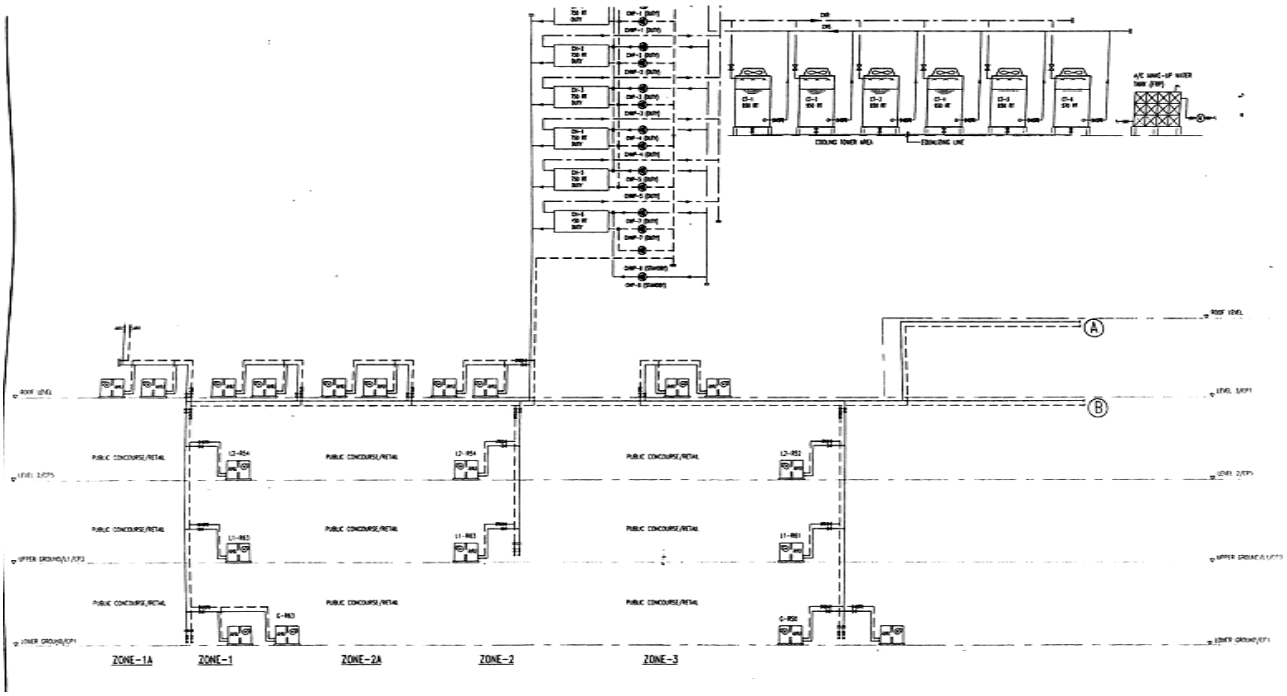


Figure 6.5: Schematic plan of chilled water system in Setia City Mall.

Figure 6.6: Picture Showing a Centrifugal chiller unit. (Source:Anon, 2011)

Analysis

The option of choosing centrifugal chiller than absorption chiller is due to the efficiency and absorption chillers. It is generally used only if there is waste heat from another available process.

5.3.1.3 Air Handling Unit (AHU)

The main function of AHUis to control the airflow within the entire building, as illustrated in Figure 6.7 and Figure 6.8. The air is draw back from the interior space, let it pass through the cooling coils, mix with fresh air and then channel back to the interiorspace.

This system is known as the constant airflow system which means the temperature of airflow will not vary and the AHU is able to provide cool air at the specific temperature. All AHU ‘s are equipped with high efficiency motor and high performance fan with total combined efficiency which is averaging at 65%. There is 63 units of AHU that are used in this building. A ductwork that distributes the conditioned air through the building and returns it to the AHU usually connected to air handles.

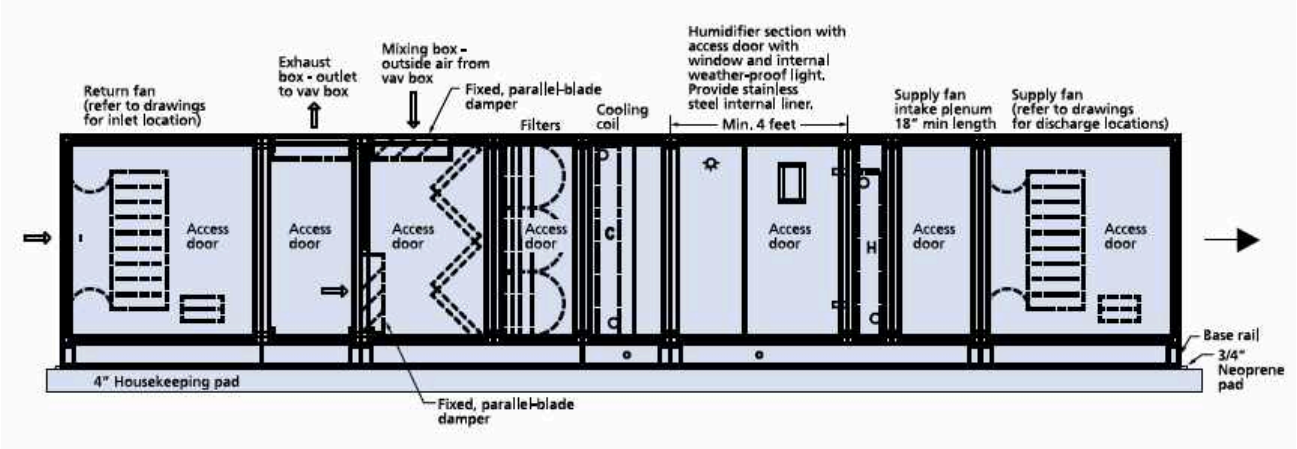


Figure 6.7: Air Handling Unit (Source: AHU. 2012).

Figure 6.8: Ducting system in Setia CityMall.

5.3.1.4 Fan Coil Unit

Fan coil unit (FCU) is a small unit that is used for cooling and usually piped with chilled water. FCU is ceiling mounted and it uses chilled water instead of refrigerant. FCU is similar to inducting system, with the inducting unit replaced by the fan-coil, the basic components found in a FCU are a finner-tube and a fan section. The fan functions to recalculates air continuously, from the coil that is supplied with cool water.

Figure 6.9:Fan Coil Unit(Source: Fan coil. 2010).

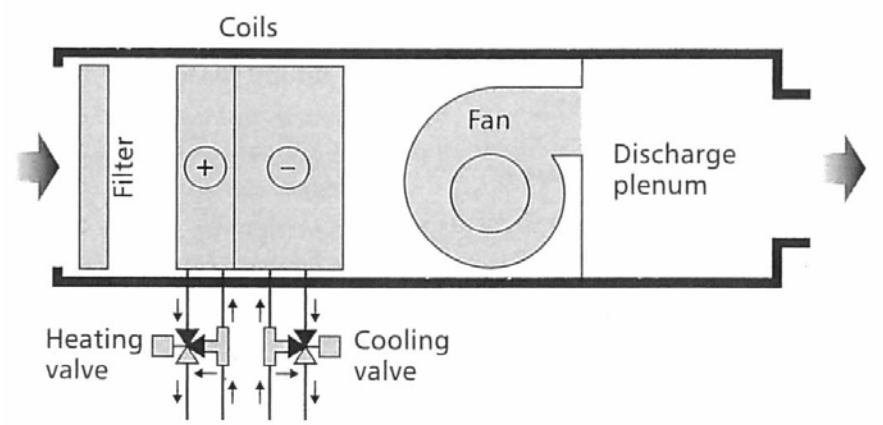


Figure 6.10: Fan coil unit diagram. (Source: Fan coil unit, 2009).

Analysis

Due to the simplicity of fan coil unit and it is also more economical to install than ducted or central heating systems with air handling units.However, the disadvantage is fan coil can produce noisiness because the fan is within the same space. Unit configurations are numerous including horizontal (ceiling mounted) or vertical (floor mounted).

5.3.2 Mechanical Ventilation system

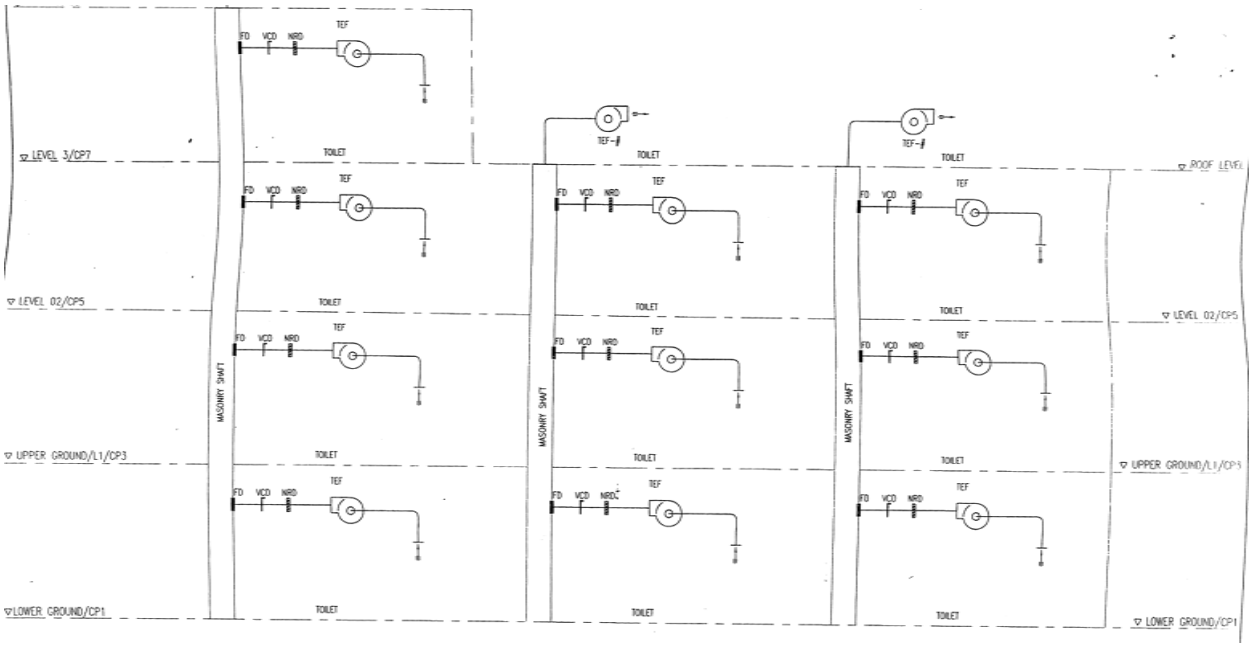


Figure 6.11:Toilet exhaust schematic drawing in Setia City Mall.

5.3.2.1 Exhaust Fan

Exhaust fan is a fan to control the indoor air environment by removing the unwanted air, such as, odors, particulates, moisture, smoke, and all the other chemicals in the air. The location for the exhaust fan is usually at the bathroom and kitchen. Exhaust fan is comparatively easy to install so they can be installed in almost any place. Appliances of mechanical ventilation system that Setia City Mall applying are Kitchen Exhaust Fan, Kitchen Make up fresh air, Smoke make up fan, Smoke extraction fan, toilet exhaust fan and fresh air fan.

Laws of Malaysia

ACT 113 STREET, DRAINAGE AND BUILDING ACT 1974

SPACE, LIGHT AND VENTILATION

Section 41

(4) Where permanent mechanical ventilation in respect of lavatories, water closets, bathrooms or corridors is provided for and maintained with accordance with the requirement of the Third Schedule to these By-Laws. The provision of the By-Laws relating to natural ventilation and natural lightning shall not apply to such lavatories, water closets, bathrooms or corridors.

Figure 6.12: Kitchen exhaust fan

Figure 6.13: Kitchen makeup fresh air fan

Figure 6.14: Smoke make up fan

Figure 6.15: Smoke extraction fan

Figure 6.16: Toilet exhaust fan

Figure 6.17: Fresh air fan

Analysis

Referring the appliances that were applied in Setia City Mall, which are the mechanical ventilation system and air conditioning, both of them have followed the law by UBBL and this mall also achieve minimum energy usage in order to meet human comfort level within this building.

5.4. Conclusion

The use of air conditioning and mechanical ventilation system in this building is appropriate according to the function of this building. The selection of the correct system and the placement equipment and so does the numbers of units are appropriate to serve the areas so that this building can achieve maximum comfort level while it is in use. It is assumed that there will be no more extension for this building vertically, and there will be no consideration given for the future extensions of ductwork or equipment.

Selection of the equipment in specific area such as FCU (Fan Coil Unit) placements in the parking area due to minimum time spent there and the noise level in consideration of the occupants of this building. Other than that, AHU (Air Handling Unit) in the shopping area is the most practical selection of this building.

6.0 Mechanical Transportation System

6.1 Introduction

Vertical transportation is transportation of passengers travelling between each floor levels in a building. Vertical transportation provides convenience for passengers to travel between different levels of floors in the building. Mechanical transport includes lift, escalators and travelators. The distance and location of lift and escalator are designed based on UBBL (Uniform Building By Law). The Consideration of division of rider traffic between lifts and escalators in a mall is important. The general philosophy of store owners is to make escalators the primary means of vertical transportation for the reason of merchandise exposure.

6.2 Literature Review

Lifts Transport System

According to *UBBL 1984 clause 124*, a lift shall be provided for non-residential building which exceeds 4 storey above / below main entrance .Ideal performance of a lift installation will provide minimum waiting time for each floor, comfortable acceleration, rapid transportation and rapid loading and unloading at all stops. The unit of lift required in a building is determined by the population of the building, function of the building, number of floors and height of the building, initial cost and maintenance cost. The elevator can be divided into 3 main types, which are hydraulic system elevator, traction system elevator and motor room-less system. The system used for the case studying building Setia City Mall is motor room-less elevator (MRL) system. This system can eliminate the need of fixed machine room.

Escalator System

Escalator is a conveyor transport device for carrying people between different levels of a building, is so-called 'moving staircase'. Escalator has the capacity to move large numbers of people with no waiting interval. Escalator is also an important architectural design impact because elevator can be used to guide people towards main exits or special exhibits. Escalators can be constructed in three ways, two of which are parallel arrangements and one crisscross arrangement. Parallel arrangement is up and down escalators are arranged side by sideor separated by a distance.Crisscross arrangement minimizes the structural space requirements by stracking excalators to go in one direction. Consideration of arrangement is based on the need and area of the space.

6.3 Case Study

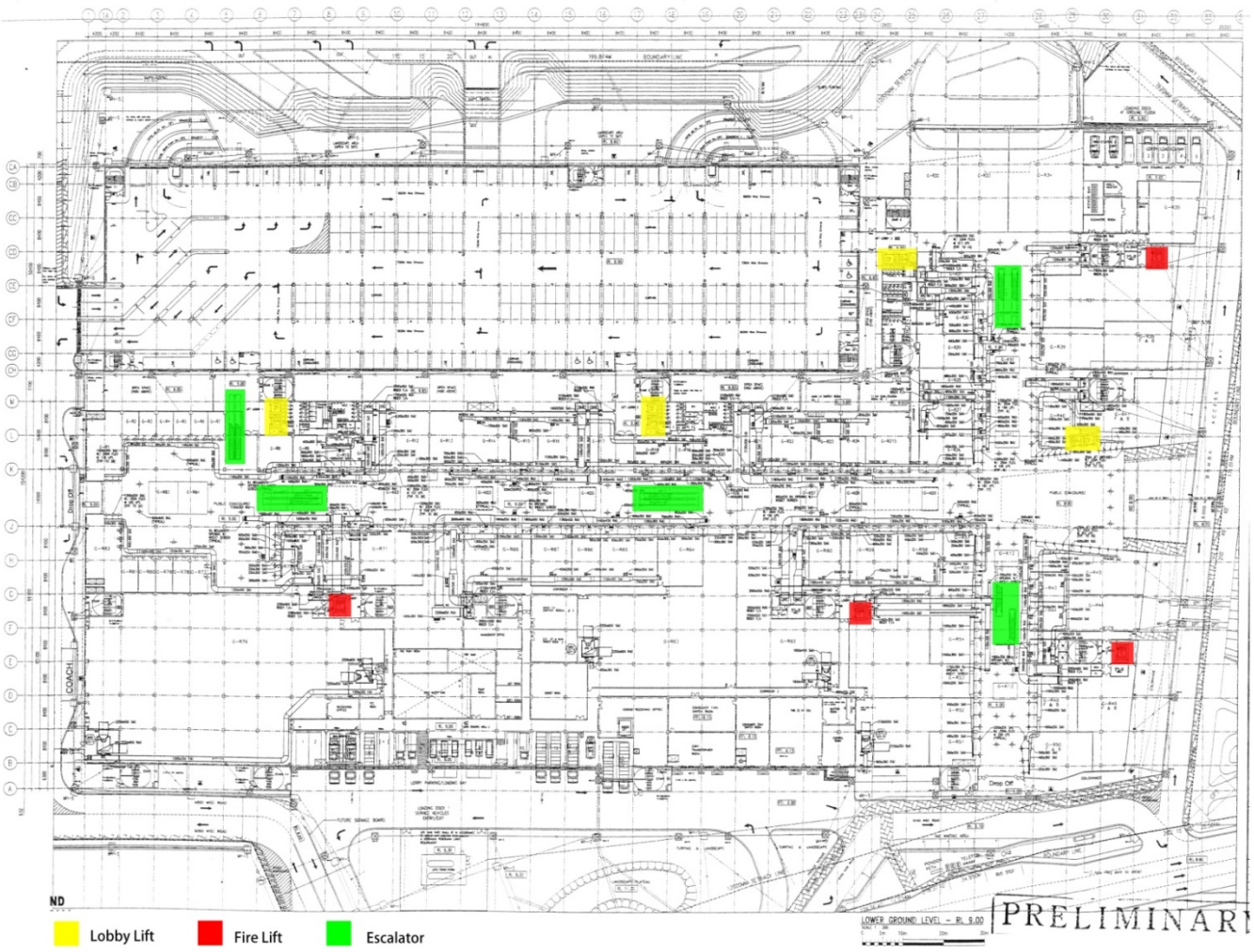


Figure 6.1:Location of the mechanical transportation system in Setia City Mall

6.3.1Lift System

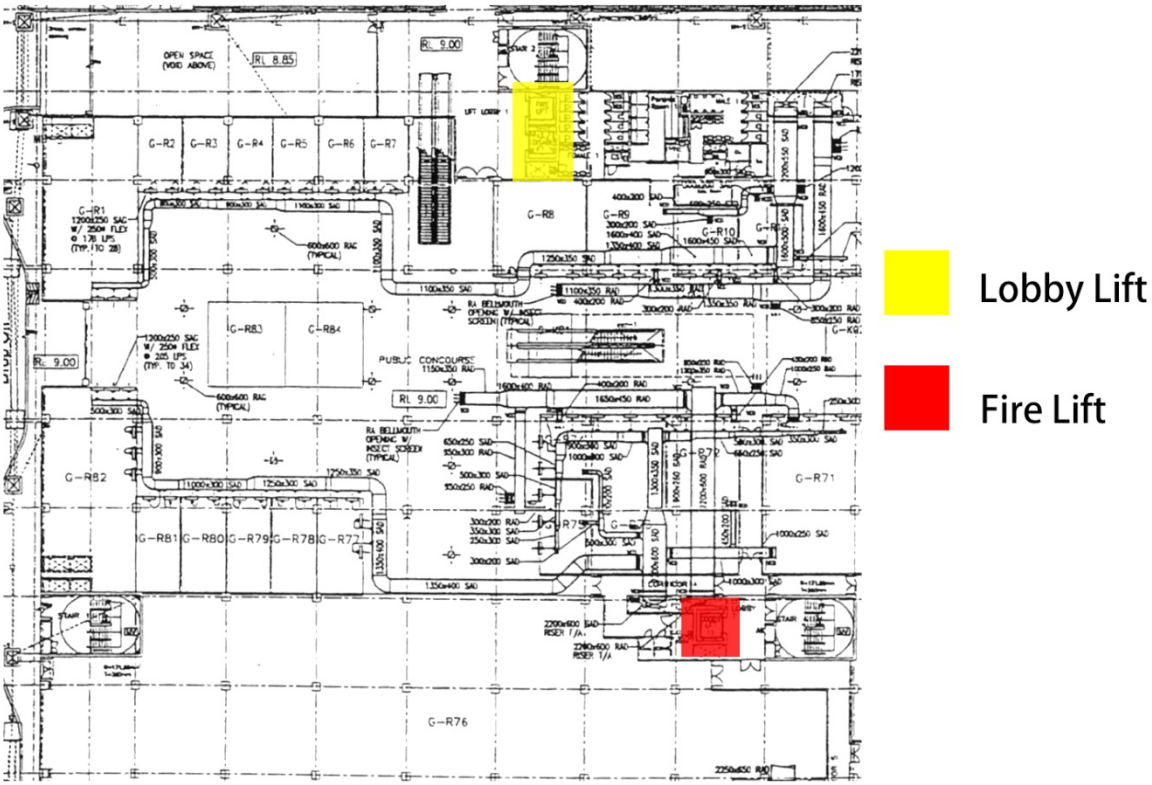


Figure 6.2: The Location of the vertical transportation system

UBBL Requirement

UBBL CLAUSE 153

A smoke detector has to be provided at the lift lobby. Lift lobby should be large enough to allow traffic to move in two directions. Referring to UBBL 1984 clause 124, a lift shall be provided for non-residential building which exceeds 4 storeys above or below main entrance. It is also essential in building less than 4 storeys if access for elder or disabled is required. Minimum walking distance to lift shall not exceed 45m. Lift should be sited in the central area of a building to minimize the horizontal travel distance.

6.3.1.1 Lifts Components

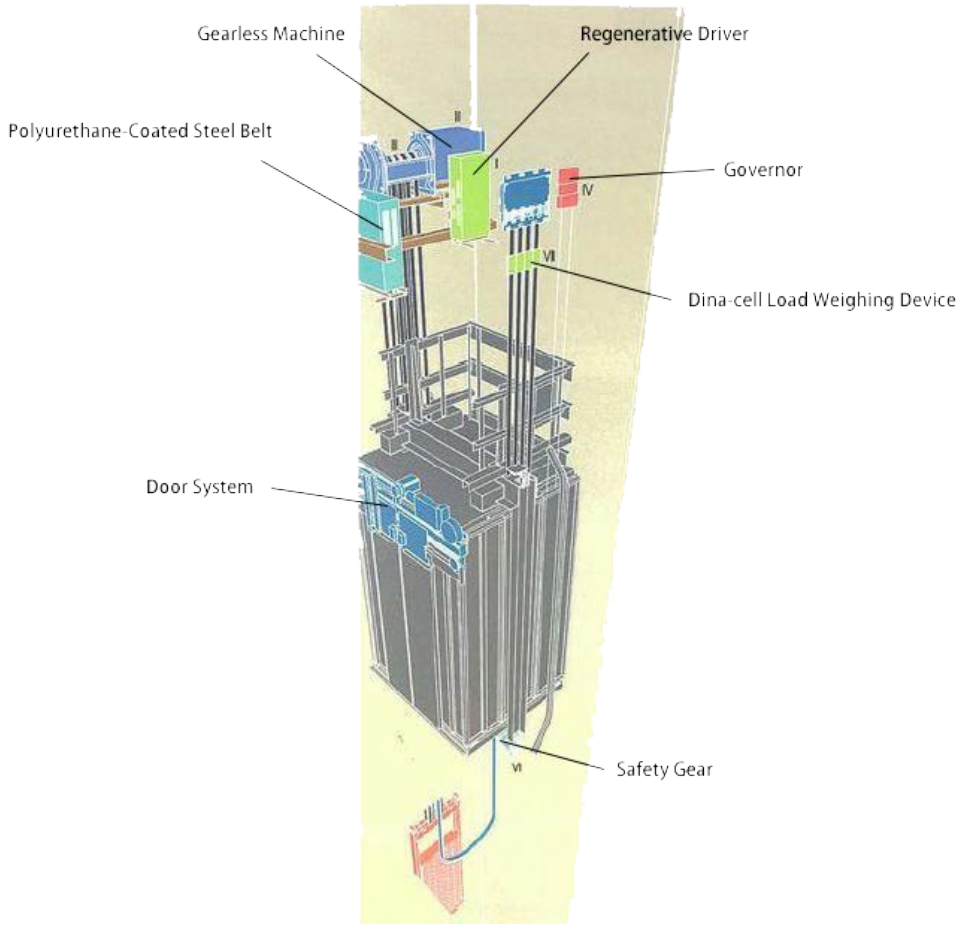


Figure 6.3: The components of the typical liftstructure
(Source: Setia City Mall Building Maintenance Guideline)

6.3.1.1.1 Regenerative Driver

The unique regenerative technology can transfer the potential energy to green electrical power which could be sent to internal grid. Obviously, it could achieve high energy saving.

Figure 6.4: Regenerative Driver

6.3.1.1.2 Gearless Machine

It used in high rise applications whereby the drive motor and drive sheave are connected in line on a common shaft, without any mechanical speed reduction unit located between the drive motor and drive sheave. The innovative design for gearless machine lead to the refinement and high-efficiency, building space saving.

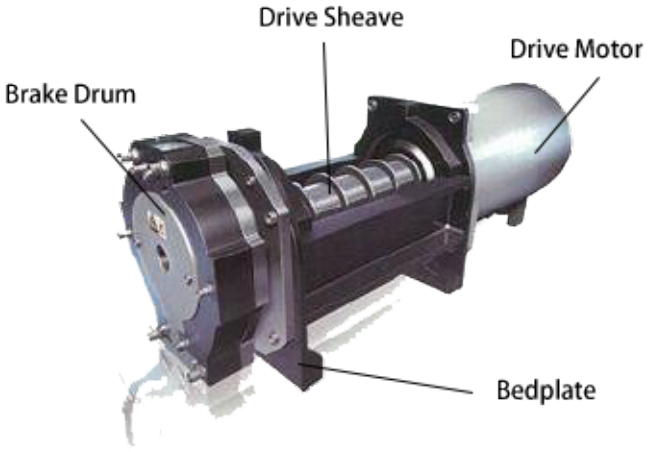


Figure 6.5: Gearless machine

6.3.1.1.3 Polyurethane-Coated Steel Belt

A core renovation of the traction system; Conventional steel rope is replaced by greeneer, lighter, tougher ad more flexible polyethane-coated steel belt. Subsequent renovations for drive machine and control system are made accordingly.

Figure 6.6: Polyruethane-coated steel belt

6.3.1.1.4 Governor

Conventional elevator safety equipment includes an over-speed governor for impeding elevator car movement when a predetermined speed is exceeded.

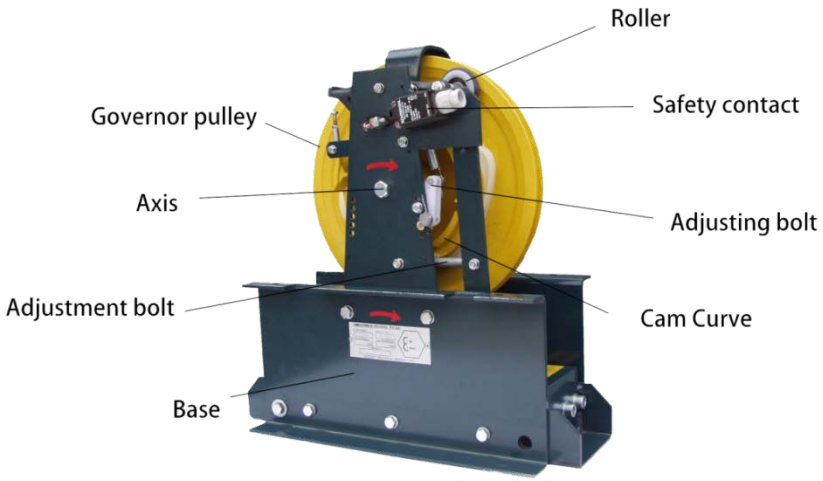


Figure 6.6: Governor

6.3.1.1.5 Door System

The mechanical coupling is solid, allowing smooth linear action of the car door and similar operation.

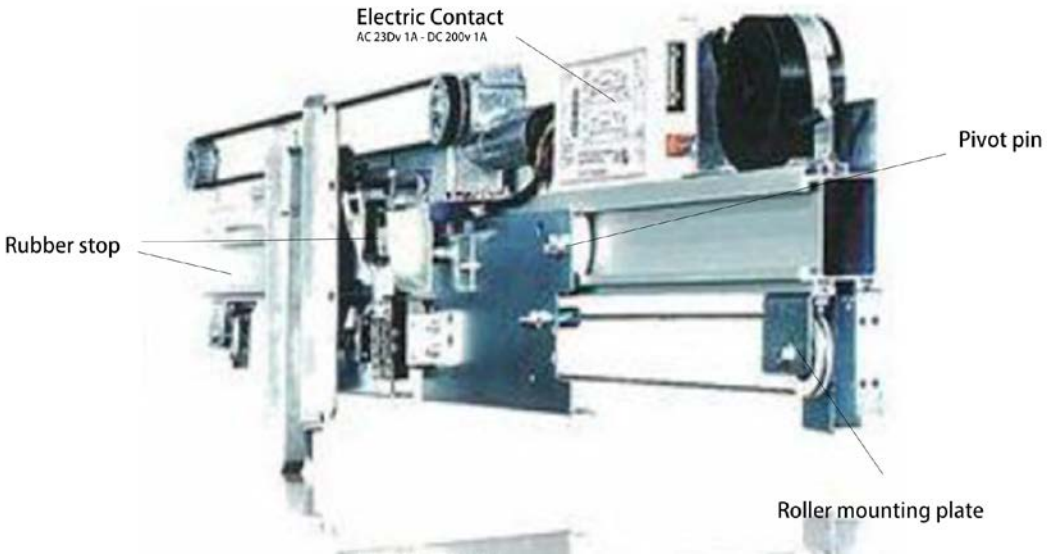


Figure 6.7: Door system

6.3.1.1.6 Safety Gear

Safety gear is a mechanical device for stopping the car (or counterweight) by gripping the guide rails in the event of car speed attaining a pre-determined value in a downward direction of travel, the reason for the increase in speed may be irrespective.

Figure 6.8: Safety gear

6.3.1.1.7 Dina-cell Load Weighing Device

Load Weighing Device is mounted on the lower transom to sense the nearness of car floor during loading of car isolation springs. The sensor is operated by altering the distance between car floor and sling dependent on the load. Accurate weighing system, precision of sensor is in the range of 3% .

Figure 6.9: Dina-cell load weighing device

6.3.1.2 Safety System

The following list describes all the safety components used in electrical traction elevator safety system:

6.3.1.2.1 Hoist-way Door Interlock

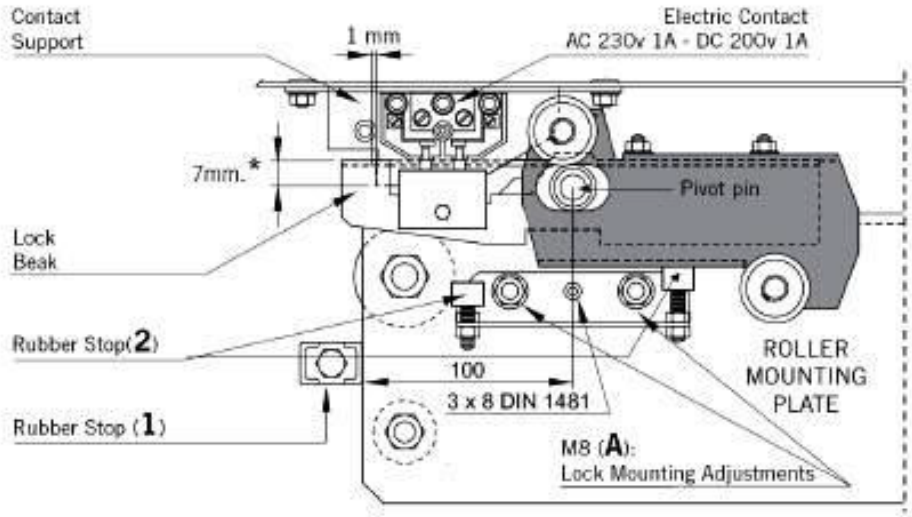


Figure 6.10: Hoist-way interlock (Source: Electrical Know How, 2013)

It shall not be possible in normal operation to open the landing door (or any of the panels in the case of a multi-panel door) unless the car has stopped, or is on the point of stopping, in the unlocking zone of the door. The unlocking zone shall not extend more than 0.2 meter above and below the landing level.The hoist-way door locking mechanism provides a means to mechanically lock each hoist-way door and the elevator cannot leave a landing unless the doors are fully closed and secured. They are also interconnected electrically to prevent operation of the elevator if any of the elevator's hoist-way doors are open. Should the doors be forced open, the interlock circuit will be broken, causing the elevator to immediately stop. Each landing door shall be provided with a locking device satisfying the previous conditions. This device shall be protected against deliberate misuse. Landing doors shall be capable of being unlocked from the outside with the aid of key, which fit the unlocking triangle (Hoist-way Emergency Door Keys).

6.3.1.1.2 Progressive Safety Gear

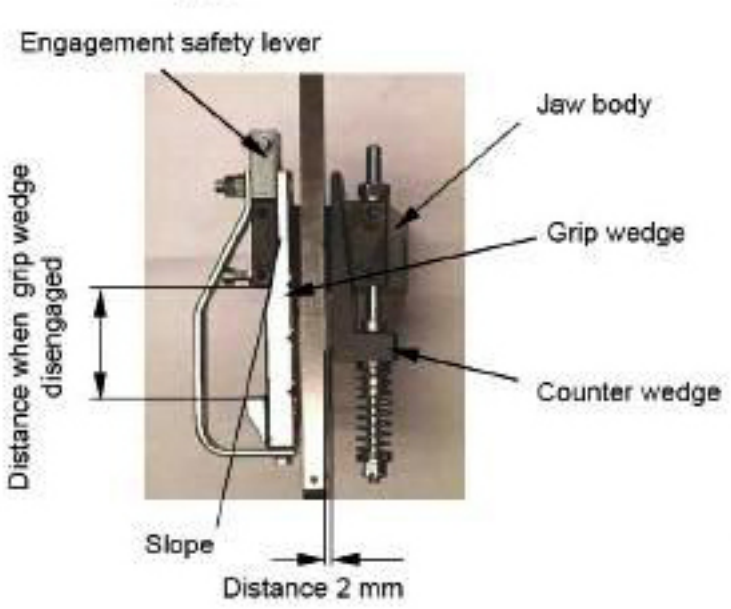


Figure 6.11: Safety gear(Source: Electrical Know How, 2013)

Progressive safety gear retardation is affected by a breaking action on the guide rails and for which special provisions are made so as to limit the forces on the car, counterweight o balancing weight to a permissible value. Pair of safety gears is mounted in the lower part of car sling and operated simultaneously by a linkage mechanism that actuated by over-speed governor.

6.3.1.1.3 Over-speed Governor

Over-speed governor function is to actuate the safety gear if the car speed exceeds 115% of its rated value. Usually a cable is attached to the safeties on the underside of the car, called the governor rope. This rope runs down through a pulley at the bottom of the shaft and back up to the machine room and around the governor sheave. When over-speeding is detected, the governor grips the cable which applies the safeties that wedge against the guide rails and stops the car. The over-speed governor works on the floating principle with a cam curve and roller guided rocker. It is situated either in the machine room or in the head room. Over-speed governor is provided by a factory adjusted switch activated when the tripped speed is reached to disconnect the machine drive starting with governor pulley blocking.

6.3.1.1.4 Buffers

Figure 6.12: Oil buffer

A Buffer is a device designed to stop a descending car or counterweight beyond its normal limit and to soften the force with which the elevator runs into the pit during emergency occasion. They may be of polyurethane or oil type in respect of the rated speed. Oil Buffer is more commonly found on traction elevators with speeds higher than 200 feet per minute. This type of buffer uses a combination of oil and springs to cushion a descending car or counterweight and are most commonly located in the elevator pit, because of their location in the pit buffers have a tendency to be exposed to water and flooding. They require routine cleaning and painting to assure they maintain their proper performance specifications. Oil buffers also need there oil checked and changed if exposed to flooding.

Analysis

Motor room-less elevator is advanced in space saving, it reduces the need for a machine roomand consumes due to the less usage of vertival and horizontal space in the building. Its small, easy-access controller cabinet and lightweight, compact machine permit more rentable building space. Low headroom requirements mean little or no roof penetration, resulting inflat and usable roofs, and unprecendented design freedom. A small closet for the compact controller cabinet replaces the conventional machine room. Located at the front of the hoistway at the top floor, the space usually requires no roof penetration. Optional alternate control space located around the perimeter of the hoistway at the top landing or in custom spaces are available.

Moreover, MRL elevator offers fast, easy installation and simpler site preparation. The compact gearless machine has several mounting configurations requiring fewer building interfaces. The standardized ordering system avoids delays and assures shipments arrive on time.Integral hall fixtures mounted in the jamb minimize cutting into lobby walls while eliminating the need to run wire protection conduit. The entrance's integrated sill support channel eliminates the need to install sill angles. Fewer interfaces with other construction trades are required in order to reduce installation time.

Compare to the motor room elevator, MRL elevator consist of high efficiency AC gearless permanet magnet motors, energy usage can be dramatically reduced over traditional geared equipment and competitive hydraulic systems which save both building building and HVAC requirements.

6.3.2 Escalator System

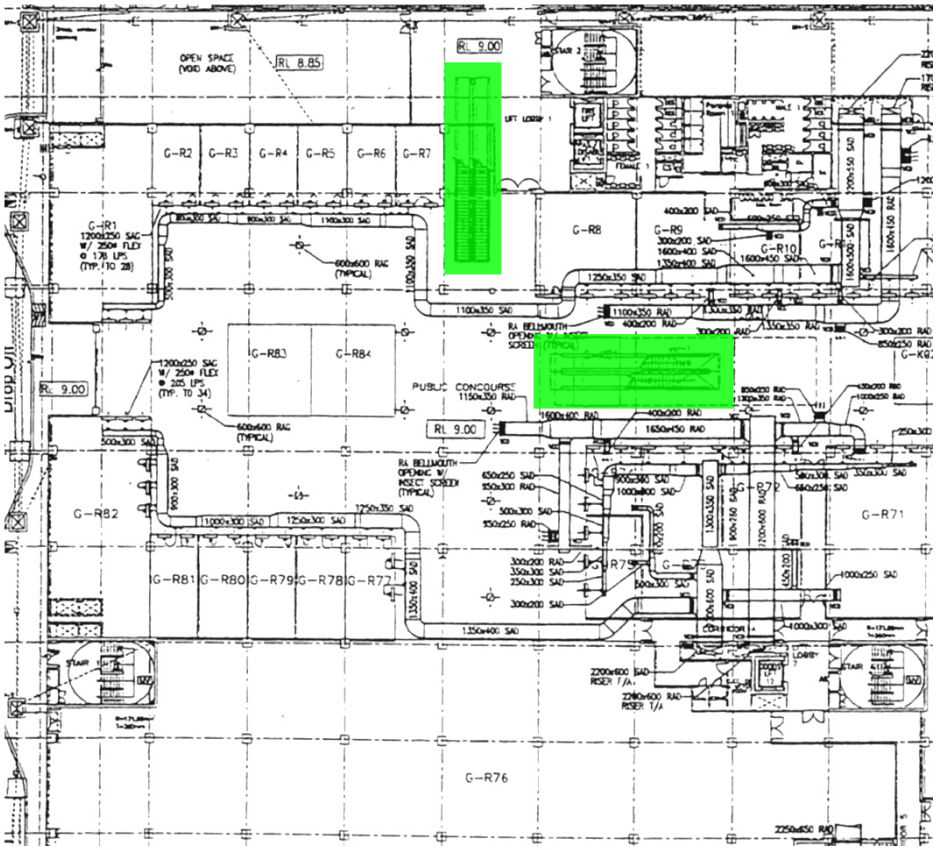


Figure 6.13: The location of the escalator

Standard Requirement

Travel speed

Travel speed of escalators is limited by code to 100 f/m (0.5 m/s). For moving walks with 0-8 degree inclination, the speed can be increased up to 180 f/m (0.9 m/s).

Travel heights and inclination

With a rise of only 6'-0" (1829), an escalator can considerably improve access to the building for the visitor. Code limits the inclination angle to 30° .Inclined moving walks typically used in shopping center and retail applications are permitted a maximum angle of 12°.

Step and pallet widths

A clearance of 1 1/4" (30mm) for installation must be added to the dimensions on either side of the escalator or moving walk. The standard escalator step width for the North American market is 40" (1000 mm).

6.3.2.1 Escalator Component

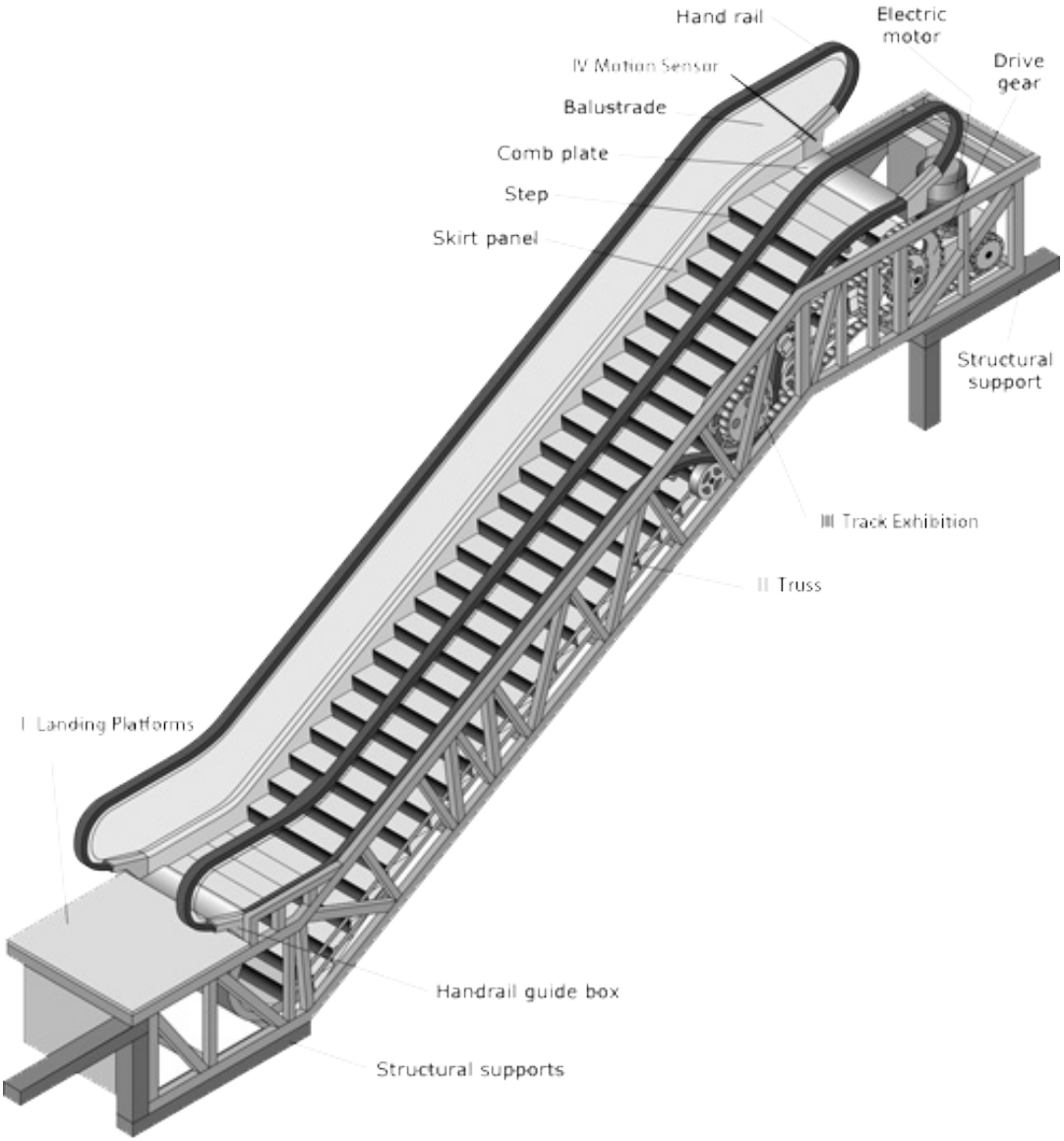


Figure 6.14: Component of the escalator
(Source: Escalator & moving walks planning guide, n.d)

6.3.2.1.1Landing Platforms

The top platform has motor assembly and the main drive gear inside, with bottom support the step return idier sprockets. The platform provides a place for the passengers to stand before they step onto the moving stairs.

6.3.2.1.2Truss

The truss is a hollow metal structure that bridges the lower and upper landings. The truss carries all the straight track sections connecting the upper and lower sections.

6.3.2.1.3 Track Exhibition

The track system continuously pulls the step from bottom platform and back to the top in an endless loop, providing non-stop moving staircase.

6.3.2.1.4 Motion Sensor

Whenever the escalator platform detects moving weight on it, the escalators works at normal speed. Thus, if there is no load on the platform for estimated duration of 60 seconds, it will be escalated at crawling speed.

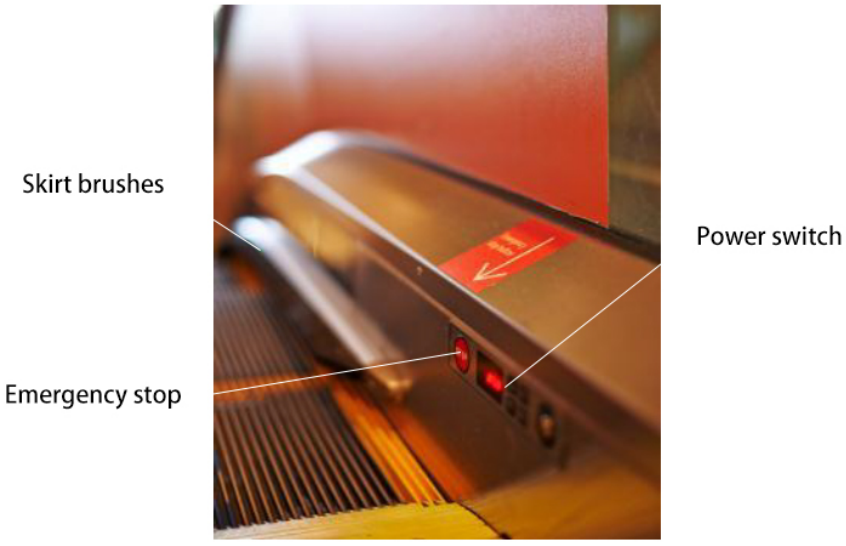


Figure 6.15: Motion sensor

6.3.2.2 Safety Manual

6.3.2.2.1Satety Zone

The entry and exit zone shall be kept clear of all obstades. The width of the zone shall be not less than the width between the centerlines of the handrail plus 8" (200mm). The Length of the zone, measured from the end of the newel, shall be no less than twice the distance between the centerlines of the handrail.

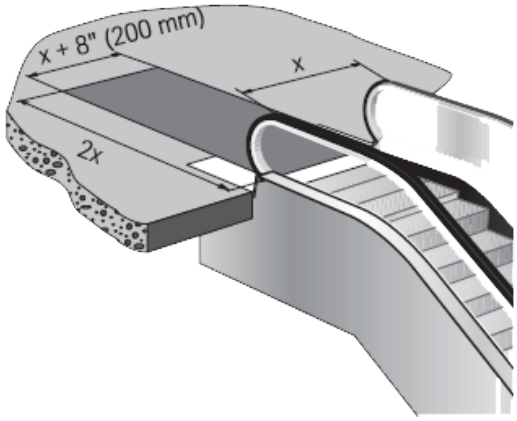


Figure 6.15: Safety zone of the escalator(Source: ThyssenKrupp Elevator Americas, n.d.)

6.3.2.2.2 Additional Deck Barricade

The use of a railing or an additional deck barricad at a height of 35" (900mm) prevents people from getting onto the escalator or moving walk from the outside of the balustrades, when outer decking exceeds 5" (127mm).

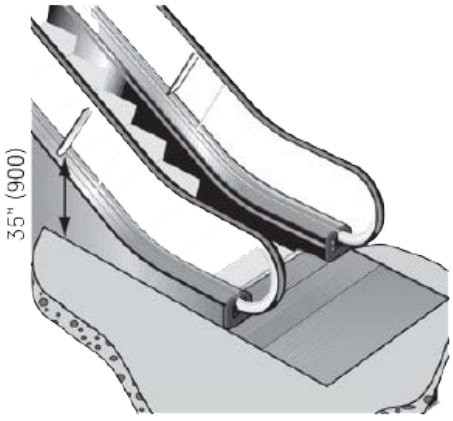


Figure 6.16: Additional deck barricade (Source: ThyssenKrupp Elevator Americas, n.d.)

6.3.2.2.3 Clear Height Above Steps

The clearance above the step or pallet band must be at least 7' - 0' (2134mm) at every location as required by code.

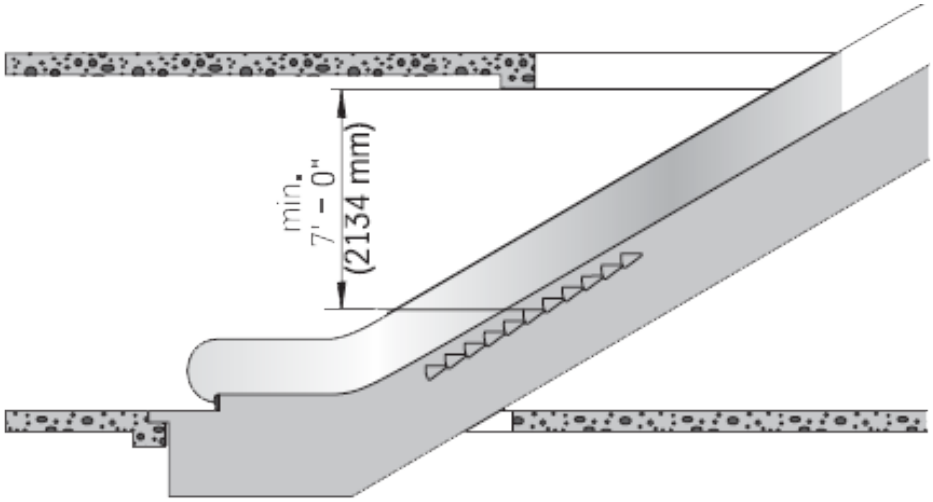


Figure 6.17:- Clear height above the escalator (Source: ThyssenKrupp Elevator Americas, n.d.)

6.3.2.2.4 Skirt Brushes

Skirt brushes are intended to prevent passenger foot entrapment within the step/skirt running clearance.

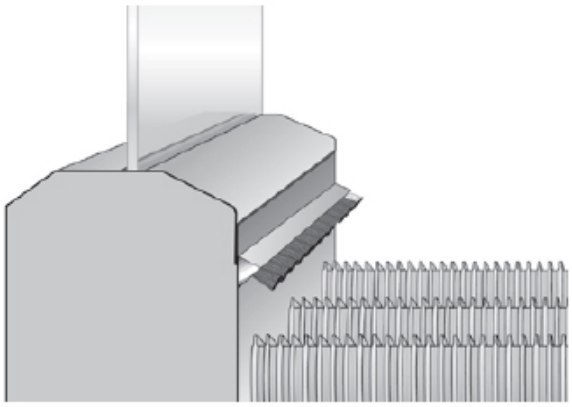


Figure 6.18: Skirt brushes (Source: ThyssenKrupp Elevator Americas, n.d.)

Analysis

The application of the motion sensor on the escalator can decrease the energy comsumption up to about 33% compare to the normal escalator with operating speed of 100 feet per minute. Beside the energy saving, this system can reduce the strain on the escalator. This result in less wear and tear, less breakdown and repairs, and an extended life of 11-13%.

6.4 Conclusion

The dynamic design of motor room-less elevator consumes comparative less amount of the buiding space, shortens manufacturing and installation times and uses less power to provide significant energy saving. It can reduce the environmental footprint of the building and qualify for LEED certification by incorporating sustainable green features in the elevator system.

Lift and escalator bring convenience to the passenger to travel between different floor levels, for safety reason, the quality of vetical transportation has been strictly controlled to avoid accident and make passenger feel comfortable and safe while using it. After inspection in-depth, it can be concluded that the construction and the design of the vertical transportation system in Setia City Mall has achieve the requirement of UBBL (Uniform Building By Law).

Conclusion

Setia City Mall had been chosen as the building of our case study on the Building services system. With the reference to the system being used in Setia City Mall and with the aid of references material such as book, literature reviews and presentation slide regarding building maintenance system conduct by the building manager's of Setia City Mall. We able to studied and understand the basic component of each system. Basic principle, process and equipment being equipped in the building services system such as Electricity supply System, Water Supply System, Sanitary, Sewerage & Drainage System, Fire Protection System, Air Conditioning System and Mechanical Transportation System.

Through the site visit and case study, we able to gain basic understanding of how each building services function in the building with including the connections, position of the different parts and component as well as space implication for each of the assigned system. All of the system adopted in Setia City Mall does not only affect the comfort level of occupants but also take in consider of safety involvement towards occupants. After completing this project, we are able to realize the importance of a building services design in order to minimize mechanical energy consumption. Consequently, the building service design is to minimize environmental impact by a building to satisfy the contemporary necessity in order to achieve sustainability.

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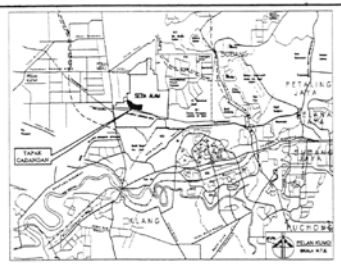

KEY PLAN
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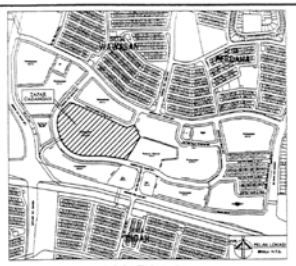
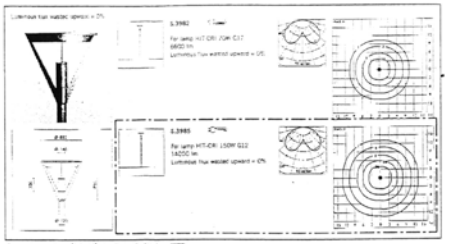


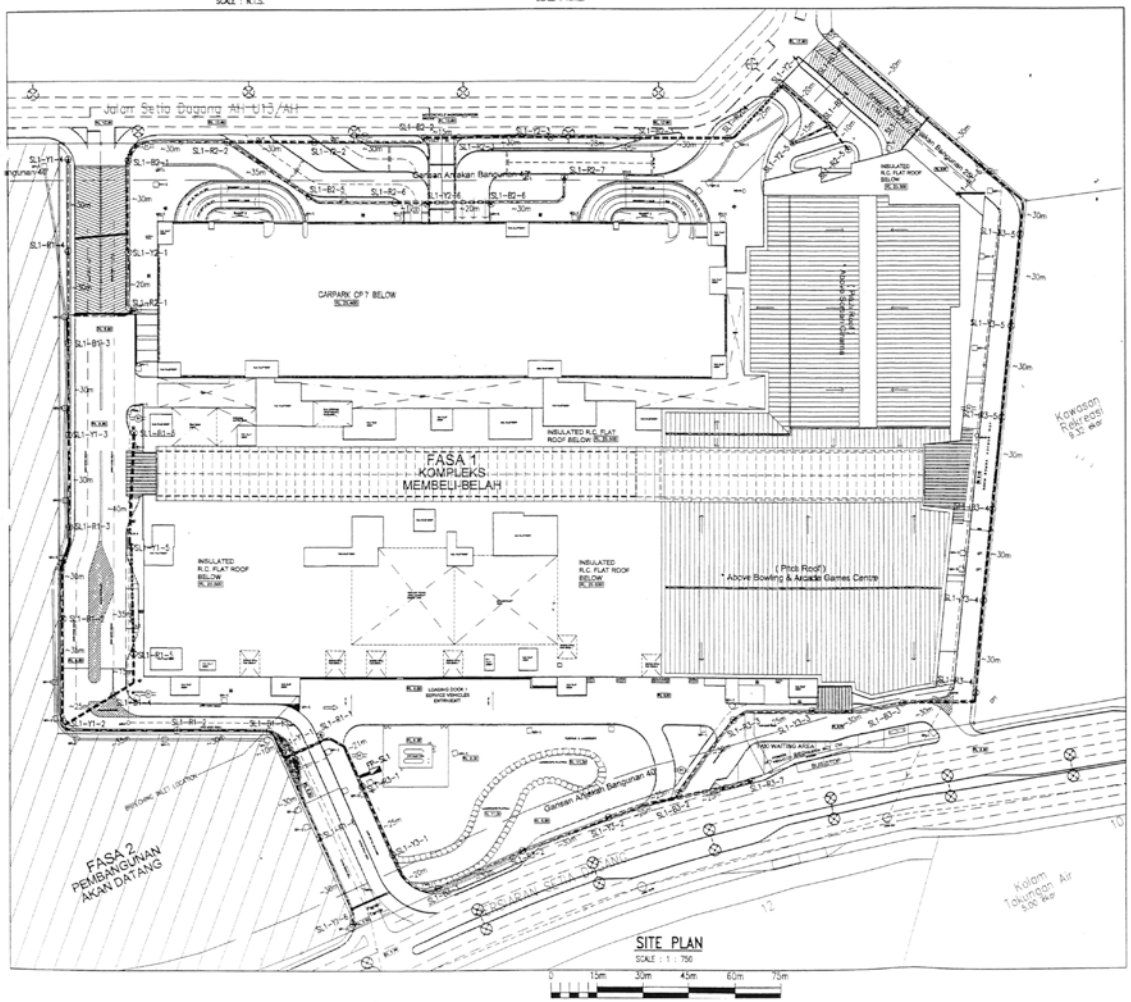
LOCATION PLAN
SCALE : N.T.S.



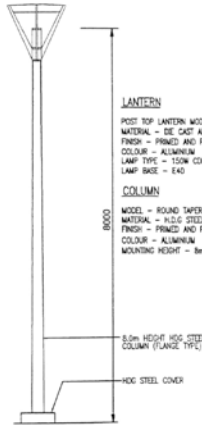
1 X 150W (5.3985) CDMT LAMP ON 8m STEEL ROUND COLUMN FOR POST TOP LANTERN

LEGEND:

- 1 X 150W (5.3985) CDMT LAMP ON 8m STEEL ROUND COLUMN FOR POST TOP LANTERN OR SIMILAR APPROVED (54 NOS.)
- 100A 3 PHASE STREET LIGHTING FEEDER PILLAR
- 100mm ϕ PVC PIPE ALONG ROAD SHOULDER
- 150mm ϕ G.I. PIPE FOR ROAD AND DRAIN CROSSINGS
- 1 x 4C-25mm² PVC/SWA/PVC CU. BURIED UNDERGROUND IN HDPE/G.I. PIPE
- 1 x 4C-16mm² PVC/SWA/PVC CU. BURIED UNDERGROUND IN HDPE/G.I. PIPE
- EXISTING 1 X 250W HPSV SON-T STREET LANTERN (NAKKON M-SERIES) MTD ON 12M MOUNTING HEIGHT WITH 2.5M ARM C/W CONTROL GEAR HINGED SERVICE DOOR C/W TELEMANAGEMENT SYSTEM (42 NOS.)
- EXISTING 2 X 250W HPSV SON-T STREET LANTERN (NAKKON M-SERIES) MTD ON 12M MOUNTING HEIGHT WITH 2.5M ARM C/W CONTROL GEAR HINGED SERVICE DOOR C/W TELEMANAGEMENT SYSTEM (39 NOS.)



SITE PLAN
SCALE : 1 : 750
0 15m 30m 45m 60m 75m



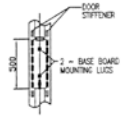
LANTERN

POST TOP LANTERN MODEL - 5.3985 C/W 150W CDMT LAMP
MATERIAL - DIE CAST ALUMINUM
FINISH - PRIMED AND PAINTED
COLOUR - ALUMINIUM
LAMP TYPE - 150W CDMT (COLOR 4000)
LAMP BASE - E40

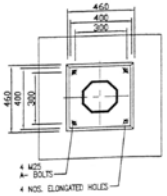
COLUMN

MODEL - ROUND TAPERED - FLANGE TYPE
MATERIAL - H.D.G. STEEL
FINISH - PRIMED AND PAINTED
COLOUR - ALUMINIUM
MOUNTING HEIGHT - 8m

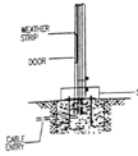
POST TOP LANTERN C/W 150W CDMT LAMP MOUNTED ON 8.0m ROUND TAPERED HDG STEEL COLUMN (FLANGED TYPE)
SCALE : N.T.S.



HINGED DOOR DETAIL
SCALE : N.T.S.



SECTION BASE FLANGE
SCALE : N.T.S



FLANGED MOUNTED TYPE
SCALE : N.T.S

AUTHORITY SUBMISSION

REV.NO.	NATURE OF AMENDMENTS	CHECKED
1	REV. AS PER LANDSCAPE CONSULTANT	

OWNER

KHOR CHAP JEN
(DIRECTOR)
BANDAR SETIA ALAM SDN. BHD.
No 1, Jalan Bandar Setia, Pusat Bandar Puchong,
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DEVELOPER

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GREENHILL RESOURCES SDN. BHD.
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Selangor U13, Setia Alam, 40170 Shah Alam, Selangor D.
Tel : 603-33448800, Fax : 603-33440797

ARCHITECT

archicentre

PROJECT TITLE

CADANGAN MEMBINA SEBUAH KOMPLEKS MEMBELI BELAH
4 TINGKAT YANG MENGANDUNGI :
A) FASA 1
4 TINGKAT RUANG PERNIAGAAN
8 UNIT PANGGUNG WAYANG
1 UNIT PUSAT BOWLING
1 UNIT PUSAT GIMNASIUM
1 UNIT PENCAWANG ELEKTRIK 33KV
2 UNIT SURAU
2 UNIT PUSAT PENGUMPULAN SAMPAH
1 BLOK TEMPAT LETAK KERETA (7 PARAS)
B) FASA 2
PEMBANGUNAN AKAN DATANG.
DI NO. 7, PERSIARAN SETIA DAGANG, BANDAR SETIA ALAM,
SEKSYEN U13, 40170 SHAH ALAM, SELANGOR DARUL EHSAN
UNTUK TETUAN BANDAR SETIA ALAM SDN. BHD.

DRAWING TITLE

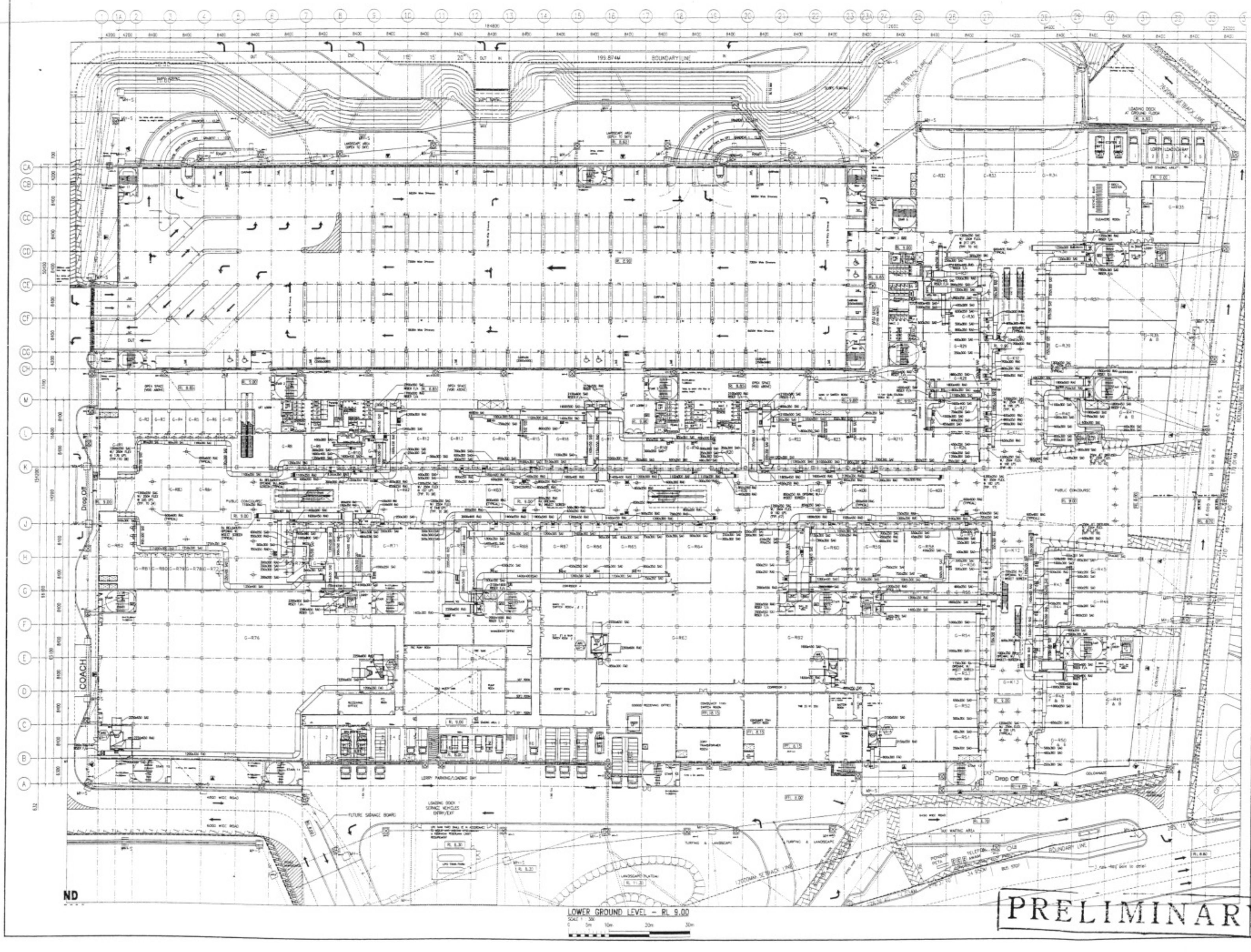
ELECTRICAL SERVICES

STREET LIGHTING LAYOUT
KEY PLAN, LOCATION PLAN
AND SITE PLAN

ORIGINAL SCALE :	AS SHOWN	ORIGINAL SIZE :	A1
DESIGNED :		CHECKED :	
DRAWN :		CHECKED :	
APPROVED :		DATE :	26-11

KTA Tenaga sdn bhd
CONSULTING ENGINEERS - JURUTERA PERUNDING
Company No. 236139-H
BANGUNAN KTA TENAGA
8TH-01, JALAN PJU 1/41,
DATARAN PRIMA, KELANA JAYA,
47301 PETALING JAYA,
SELANGOR DARUL EHSAN, MALAYSIA.
TEL: 03-78637865 FAX: 03-78637866
EMAIL: khaten@po.jaring.my

DRG. NO. : T0919/E02/006/S1



KHOR CHAP JEN
(DIRECTOR)
BANDAR SETIA ALAM SDN. BHD.

DEVELOPER

KHOR CHAP JEN
(DIRECTOR)
GREENHILL RESOURCES SDN. BHD.

ARCHITECT

archicentre

PROJECT TITLE

CADANGAN MEMBINA SEBUAH KOMPLEKS MEMBELI BELAH YANG MENGANDUNGI :

A) FASA 1

1. 4 TINGKAT RUANG PERNIAGAAN
2. 1 BLOK TEMPAT LETAK KERETA (7 TINGKAT)
3. 8 UNIT PANGGUNG WAYANG
4. 1 UNIT PUSAT BOWLING (30 LORONG)
5. 1 UNIT PUSAT GIMNASIUM
6. 1 UNIT PENCAWANG ELEKTRIK 33KV
7. 2 UNIT SURAU
8. 2 UNIT PUSAT PENGUMPULAN SAMPAH "SPIRAL WASTE BIN"
9. 1 UNIT " LPG TANK FARM"
10. 1 UNIT PONDOK HENTIAN BAS DAN TEKSI

DI NO. 2, PERSIARAN SETIA DAGANG, BANDAR SETIA ALAM, SEKSYEN U13, 40170 SHAH ALAM, SELANGOR DARUL EHSAN UNTUK TETUAN BANDAR SETIA ALAM SDN. BHD.

DRAWING TITLE

AIRCONDITIONING & VENTILATION SERVICES

LOWER GROUND LEVEL - RL 9.00

ORIGINAL SCALE : 1 : 300 | ORIGINAL SIZE : A0

KTA Tenaga sdn bhd

DRG. NO. : T0919/M02/003/T0


Lower Ground
P1
West Entrance
East Entrance
South Entrance
McDONALD'S LG-40
URBANFRESH LG-SM
DAISO LG-MM01
ANOGEN THE FURNITURE DEPOT LG-MM02
TGI FRIDAY'S LG-25/26
TAXI PICK-UP & DROP OFF
BUS STOP


Upper Ground
North Entrance
P3
UNIQLO UG-24 / 26
PADINI CONCEPT STORE UG-MM01
PARKSON UG-DS01
ZARA UG-MM02
UG-MM03 / MM04
NICHII / MARRY MERRY UG-MM05


Level 1
P5
COURTS
L1-25b
L1-25
L1-26
L1-27
L1-28
L1-29
L1-29a
L1-30
RASA FOOD ARENA
L1-24
L1-23
L1-22
L1-21
L1-31/32
L1-50/51
L1-49
L1-49a
L1-48
L1-47
L1-46
L1-45a
L1-45
L1-43a
L1-43
L1-42
L1-41
L1-40
L1-39
L1-38
L1-37
L1-36
L1-35
L1-34
L1-33
BRANDS OUTLET
L1-MM01
L1-K01
L1-K02
L1-01
L1-02
L1-03
L1-04
L1-05
L1-06
L1-07
L1-08
L1-09
L1-10
L1-11
L1-12
L1-13
L1-14
L1-15
L1-16/17
L1-18
L1-19a
L1-19
PARKSON
L1-DS02
F.O.S
L1-MM02
HARVEY NORMAN
L1-MM03
FITNESS FIRST
L1-MM04


Level 2
P7
Pet Grooming Entrance
CENTRE MANAGEMENT OFFICE
GOLDEN SCREEN CINEMAS
L2-MM03
L2-07
L2-08
L2-09
L2-06
Petsmore.com
L2-01a
L2-11a
L2-11
L2-10
L2-K11
L2-01
L2-02
L2-03
L2-04/05
L2-MM02
WANGSA BOWL
L2-MM01
L2-MM02a

TAYLOR'S UNIVERSITY

Wisdom • Integrity • Excellence

THIS IS TO CERTIFY THAT THIS IS A TRUE COPY OF THE ORIGINAL WHICH I HAVE SIGHTED

.....

Name: S. Tera

School of Architecture, Building and Design

Taylor's University

Date: 20/5/14

19 May 2014

TO WHOM IT MAY CONCERN

Dear Sir/Madam

PERMISSION TO ACQUIRE INFORMATION ON "ANALYSIS AND DOCUMENTATION OF BUILDING SERVICES SYSTEMS".

This is to certify that the following students are enrolled in the Bachelor of Science (Honours) (Architecture), conducted at School of Architecture, Building and Design, Taylor's University.

No	Student Name	IC. No. / Passport No.	Student ID No.
1	TANG HUI YING	930208015182	0312089
2	PUNG JIA CHYI	930220015126	0309585
3	LING GEE YOU	930801015247	0311338
4	VOON JIA WEN	920610135896	0312703
5	PHILIP SUTEJO	S473752	0312245
6	SYLVIA KWAN	A2269456	0311790

The students are currently enrolled for Building Services ARC2423 which requires them to do research in order to have in-depth understanding of the module.

We would be grateful if you could provide them your guidance, assistance and necessary permission in acquiring the information required. We ensure that the information gathered is strictly for academic purpose only. Any pictures of volunteers and individuals will not be used on any public websites and commercial purposes.

Should you need further clarification, please contact Mr. Mohd. Adib Ramli from the School of Architecture, Building and Design at 03-5629 5095 or MohdAdib.Ramli@taylors.edu.my.

Yours faithfully,

Tony Liew Voon Fun
Dean
School of Architecture, Building and Design

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(Co. No. 149634-D)
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