

6.0 VERTICAL TRANSPORTATION SYSTEM

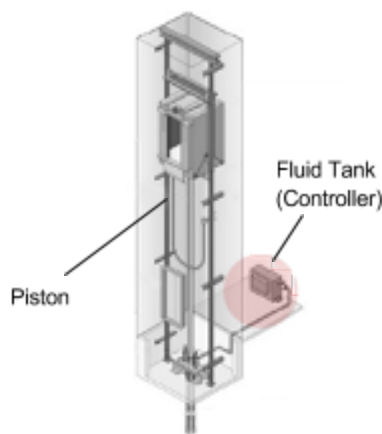
6.1 Introduction & Functions

Vertical Transportation Systems refers to the service component within a building which enables us to travel vertically between floors much quicker and effortlessly. Throughout the case study conducted on the Summit Mall in USJ, it was concluded that the mall has 3 forms of mechanical transportation system. The Escalators, Inclined Travelators and Elevators.

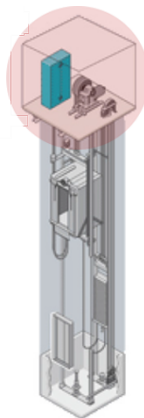
6.2 Elevators

An elevator is a transportation device used to move goods and people vertically between floors (levels, decks) of a building, vessel, or other structure. Elevators usually provide access for the elderly and disable through the floors of modern offices and public buildings.

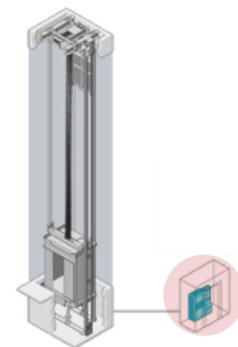
In present day, there are 2 main types of elevators that are commonly used in public buildings, that is the Electric elevators and the (i) hydraulic elevators. However, the electric elevators are classified into 2 based on the variations, the (ii) Traction with Machine Room elevators, and (ii) Machine room-less Traction Elevators.



Hydraulic Elevator



Traction With Machine Room



Machine Room-less Traction

6.2.1 Type of Elevator in Summit USJ

Summit USJ Subang uses KONE Ecospace machine room-less (MRL) elevators, which do not require a machine room above the elevator shafts. Due to the size of KONE EcoDisc hoisting motor, the elevators do not need a separate machine room. The reduction of the sheave size, alongside a more compact redesigned machine allows the machine to be assembled within the hoistway itself, saving valuable floor space and the need of a bulky machine room. There is no need for a control room as the KONE EcoSpace control and logic components fit inside the wall of the top elevator landing. Most machine room-less elevators are used for low to mid rise buildings. Machine room-less elevators in mid-rise buildings usually serves up to 20 floors. They are comparable to geared traction elevators in terms of initial and maintenance costs, but they have relatively low energy consumption compared to geared elevators.



Diagram 6.1 KONE Ecospace Machine Room-less (MRL) Elevator in Summit USJ

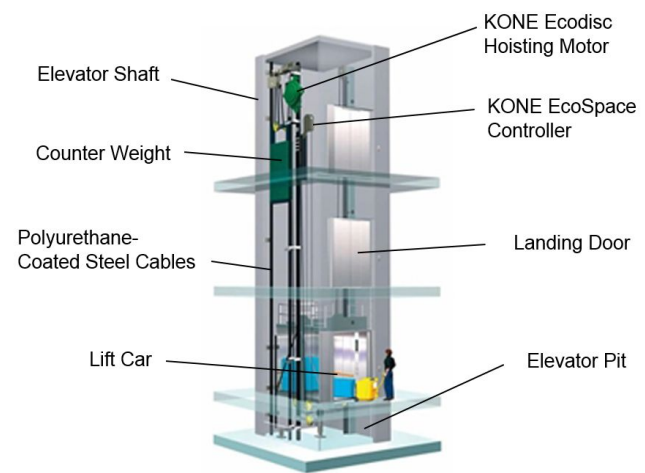


Diagram 6.2 Components of an Machine Room-less elevator device

6.2.1.1 Passenger Lifts & Firefighting Lift

In USJ Summit building, there are 7 firefighting lift and 24 passengers lift in total. The Passenger lift are capable of transporting 25 persons at a time with the weight limit of 1705 kg. The passenger lifts are equipped with the fireman switch. When the switch is turned on, elevators are directed to the fire recall floor. Elevators traveling away are then reversed back to the designated floor without stopping. Upon reaching, passengers are able to exit the elevator and building safely. The elevators are then removed from normal service. Once removed from normal service, the elevators will no longer accept car or hall calls. This mode of Fire Service allows firefighters to continue to utilize the elevator to rescue people from other floors.



Diagram 6.3 The exterior and interior view of the Passenger Lifts



Diagram 6.4 The Fireman switch installed on the side façade of the elevator

On the other hand, the firefighting lift is an elevator within the firefighting shaft with dual power supply and is capable of being commandeered by the fire service department. The firefighting lifts are capable of transporting an approximate amount of 27 people, with the weight limit of 1835 kg.



Diagram 6.5 The firefighting lifts in Summit USJ are labelled with red sign stating 'Lif Bomba'



Diagram 6.6 The interior of a Fire Fighting Lift

6.2.2 Elevator Components

6.2.2.1 Elevator Car

Elevator Car is the cabin that travels between different landing floors carrying passengers and goods, it is usually a heavy steel frame surrounding a cage of metal panels, mounted on a platform within an enclosed space. The Elevator Car type used in Summit USJ is the Normal Cabin elevator, which has only one opening. The elevator cabin has weight limit of 1705 kg, a maximum of 25 pax.



Type	Q (Kg)	Persons	CW(mm)	CD(mm)
Type (I)	320	4	1000	900
	400	5	900	1000
			1100	1000
			1000	1100
	480	6	1200	1100
			1100	1200
			1400	1100
	630	8	1100	1400
Type (II)			1200	1300
	750	10	1400	1300
			1300	1400
	800	10	1400	1350
			1350	1400
			1600	1400
	1000	13	1400	1600
			1100	2100
	1050	14	1600	1500
	1350	18	1600	1800
			2100	1600
	1600	21	1400	2400

Diagram 6.7 The types of elevator cabin used in Summit USJ & the required dimensions for various lift

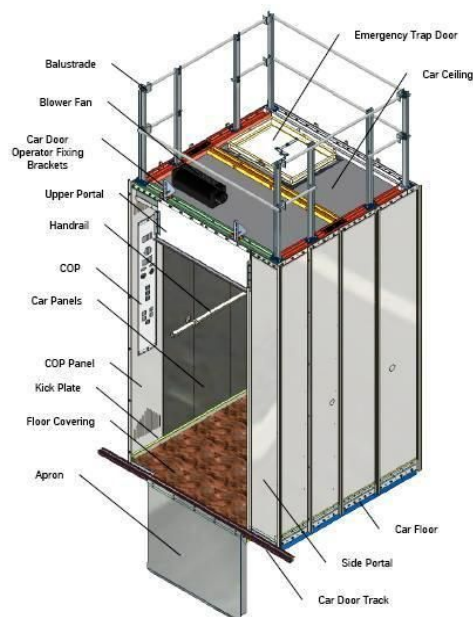


Diagram 6.8 The components within an elevator car

(i) Infrared Door Sensor

Infrared sensors are installed in Summit Mall's elevator to detect passengers on the doorway, preventing the doors from closing which may any accidents to happen. Elevator door will reopen and hold for a specific period of time until the passenger leaves the doorway. Nudge mode of elevator will be initiated if the lift door has been blocked more than the set period of time to inform the passengers that the door is closing with a continuously beep. Door sensors in elevators in Summit work with independent power supply to make sure it works.



Diagram 6.9 Infrared Door Sensor in Summit USJ

(ii) Buttons, Key Controls and System Controls

In Summit, all compulsory buttons in each lift car are provided on the control panels such as the hall button, floor request buttons, open and close door buttons, emergency stop button, emergency bell button and the registration panels. The key controls of the elevator are located below the floor request buttons to allow various functions to be turned on and off by the management staffs or firefighters who hold the key to carry out operations like maintenance, fire department control, elevator on or off etc. On the other hand, system controls in Summit are located in elevator control room to control its operation during daytime or night.



Diagram 6.10 Elevator at Summit (left) Illustration of the buttons and controls (right)

6.2.2.2 KONE Ecodisc Hoisting Motor



Diagram 6.10 *Ecodisc Motor installed within hoistway*

KONE's machine room-less (MRL) technology eliminates the need for a machine or control room by attaching its KONE Ecodisc Hoisting Machine to the guard rail, while placing all controls and logic components within the confined space of the hoist way. The hoisting motor is capable of transporting people and goods to a maximum distance of 76m and a travelling speed of 152m per minute.

6.2.2.3 KONE Ecospace Controller



An Elevator Controller is a system to control the elevators, either manual or automatic. The control system used in USJ Summit Buildings are of KONE Ecospace controller, which provides advantages in space saving and simplified installation. There is no need for a controller room as the KONE Ecospace Controller and other logic components are fit inside the wall of the top elevator landing. This speeds up the installation process, since no scaffolding or crane is needed.

Diagram 6.11 *Controller installed within the wall of top landing*

6.2.2.4 Escalator Driving Sheave



Diagram 6.12 Sheave as a gear for traction elevator

An escalator sheave is a deeply grooved pulley attached to the elevator's machine. Compared to the conventional traction elevators, the driving sheave of KONE Machine Room-less elevator is reduced in size. While the lift rates are slower than in a typical gearless elevator, the gear reduction offers the advantage of requiring a less powerful motor to turn the sheave. Optimally shaped magnets are attached directly to the sheave to produce a gearless motor with smooth, noiseless operation.

6.2.2.5 Polyurethane-Coated Steel Cable

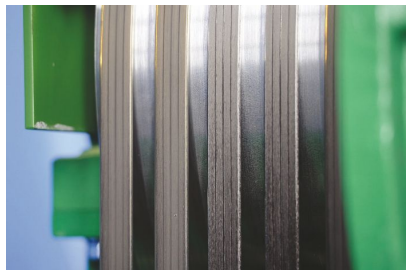


Diagram 6.13 Polyurethane-Coated Steel Cables

The KONE machine room-less elevators do not use traditional steel cables. Instead, Polyurethane-Coated Steel Cables have replaced them, providing unrivalled elevator eco-efficiency, reliability and durability, while also improving elevator performance. It eliminates the disadvantages of existing steel ropes – high energy consumption, rope stretch, large moving masses, and downtime caused by building sway. These cables are only 3mm thick, therefore allowing the KONE elevators to have smaller sheave.

6.2.2.6 Counter Weight



A counterweight carried by an elevator cable to balance the weight of an elevator cab; the counterweight travels downward when the cab travels upwards and vice versa. The counterweight is usually steel plates stacked within a frame. Having a counterweight eases the motor to raise and lower the car, provided that there is sufficient counterweight top clearance the car bottom run by is recommended to be somewhere in between 150mm to 600mm.

Diagram 6.14 Counterweight balancing the elevator and its load

6.2.2.7 Guide Rails



Guide Rails in an elevator are steel tracks in the form of a 'T' that run the length of the hoist way. The guide rails have guiding surface to guide and direct the course of travel of an elevator car and elevator counterweights. They are usually mounted to the sides of the hoist way. The guide rails are fixed to the hoist way by means of steel brackets.

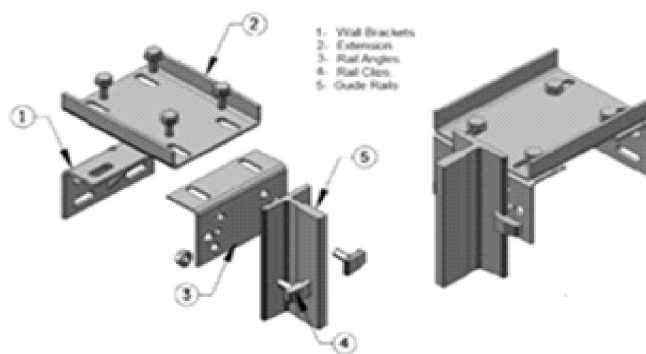


Diagram 6.15 Brackets to fix the elevator cars onto the guard rails

6.2.3 Operation of Elevator System

6.2.3.1 Type of Elevators Control System

In Summit, the elevators are in the setting of two-car selective collective operation. This operating system is the most common application in buildings for two cars under group control as it remembers all car calls and proceed to the destination in one direction then reverse its direction again. In each escalator landing, the up and down buttons are provided except in the highest and lowest floor of the building. There are car buttons provided on car operating panel in each elevator cars. The operation of elevator begins when lift users press hall call button to register a hall call, it will initiate one of the two cars to be assigned to the lift lobby. After users enter the lift car, it will respond to the next car call registered by other users at any lift lobby. If all hall calls and car calls have been answered in which the direction of the car is traveling, the car will then travel in an opposite direction to receive any halls calls and car calls assigned to it. Users are required to press hall call and car call buttons by hand in order to operate the cars.

6.2.3.2 Safety Mechanisms in Elevators



Diagram 6.16 Main break in Elevator

The safety mechanism found in elevators is the main break located directly on the shaft. The elevators start to slow down by the dynamic braking of the motor. The main brake is then operated to clamp down on the brake drum, this will hold the car still at the floor. There is a dual safety device that is used to stop the car automatically in case the elevator over-speeds.



Diagram 6.17 Overspeed Governor in Elevator

The over speed governor will cut the power supply towards the motor and activates the brakes if the speed limit of the escalator is exceeded. This will slow down the elevator car significantly. The governor will trigger another two safety rail clams if the speed of the escalator remains. The rail claims are located at the bottom of the elevator car with one at each side. Spring and rubber buffers are placed in the pit to aid and act as a cushion for the falling car.

6.2.4 UBBL Requirements & Regulations for Elevator

Uniform Building By-Laws 1984	Analysis
<p>Section 124:</p> <p><u>Lift</u></p> <p>For all non-residential buildings exceeding 4 storeys above or below the main access level at least one lift shall be provided.</p> <p>Section 151:</p> <p><u>Ventilation to Lift Shafts</u></p> <p>Where openings to lift shafts are not connected to protected lobbies, such lift shafts shall be provided with vents of not less than 0.09 square metre per lift located at the top of the shafts. Where the vent does not discharge directly to the open air the lift shafts shall be vented to the exterior through a duct of the required FRP as for the lift shafts.</p>	<p>Summit mall consisting of 5 floors is installed with 24 Passenger Lifts & 7 Fire Fighting Lifts.</p> <p>Two fans are installed to each lift device on the top part of the shaft.</p>

Section 153

Smoke Detectors for Lift Lobbies

1. All lift lobbies shall be provided with smoke detectors.
2. Lift not opening into a smoke lobby shall not use door reopening devices controlled by light beam or photo-detectors unless incorporated with a force close feature which after thirty seconds of any interruption of the beam causes the door to close within a preset time.

Photoelectric smoke detectors are installed at every lift lobbies at Summit Mall.

Section 154:

Emergency mode of operation in the event of mains power failure

1. On failure of mains power all lifts shall return in sequence directly to the designated floor, commencing with the fire lifts, without answering any car or landing calls and park with doors open.

During power failure, all lifts at Summit Mall will automatically stop at ground floor with doors open.

6.3 Escalators

An escalator is a vertical transportation device in the form of a moving staircase – a conveyor which carries people between levels of a building. It consists of a motor-driven chain of individually linked steps which remain horizontal, allowing the user to stand still while transporting user to the next floor. The escalator provides an immediate means of transportation, being able to convey continuously to transport a large number of people. An elevator can be reversible to suit the main flow of traffic during peak hours. The escalators used in Summit Mall USJ are of the brand KONE.

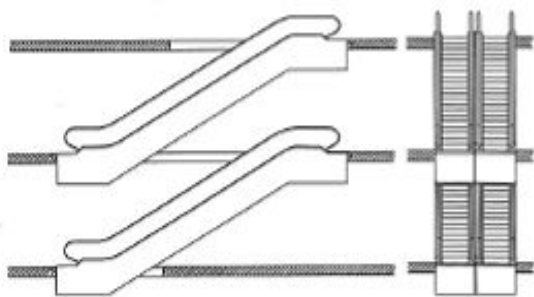


Location of Escalators

In Summit USJ, the escalators are positioned next to the main entrance at ground floor and center part of the upper floors to permit efficiency of transportation and circulation. The escalators allow easy access through the main circulation of the retail podium which lead people towards promotional space or alongside display of merchandise at Summit.

Diagram 6.18 Escalators in Summit USJ

Escalator Inclination and Speed



Inclination of the escalators in Summit USJ is 30° which provides the maximum safety and comfortability to the user. They are running a speed of 0.5 meters per second at Summit which is an optimum speed to retain shoppers at the mall for a longer period of time.

Diagram 6.19 Side Elevation & Front elevation of escalator

6.3.1 Arrangement of Escalators

The elevators in Summit Mall USJ is positioned in a multi-level parallel arrangement. The escalators are used to create a connection between ground floor to the fourth floor of the retail podium. Multi-level parallel arrangement is used due to economical as there is no inner layer of lateral claddings required which is covered by another escalator beside. The mall utilizes this arrangement as one of the sales strategies since passengers have to make a short detour in order to access to next escalator to go up or down. Displays of merchandise are strategically located along the way to increase sales in Summit. Sometimes, Summit will reverse the travelling direction of escalator if the traffic flow is high during peak season. However, the direction of users' traffic will be reversed to make a big U-turn in order to access to another escalator going up or down. Overall traveling time of passengers between floors will be increased.

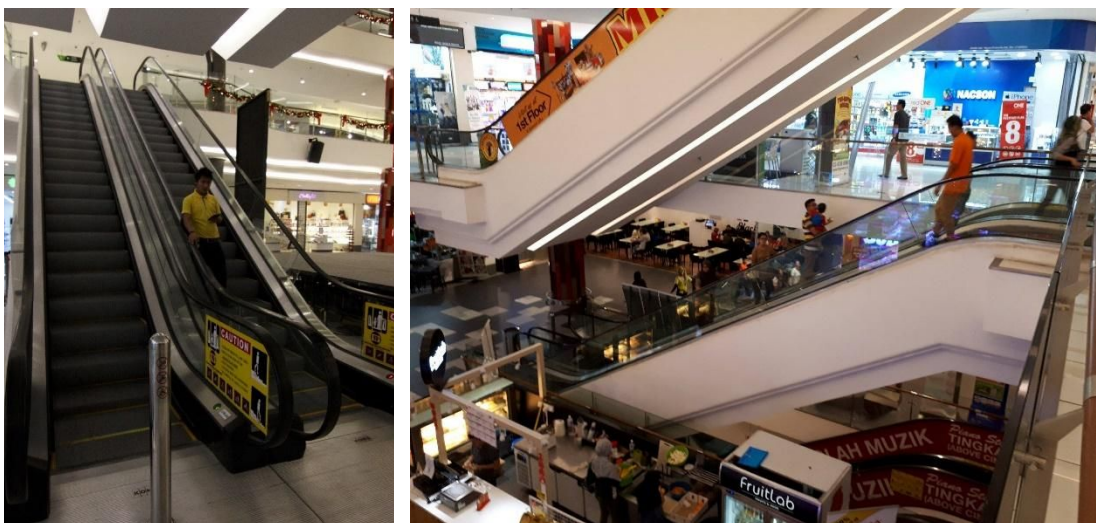
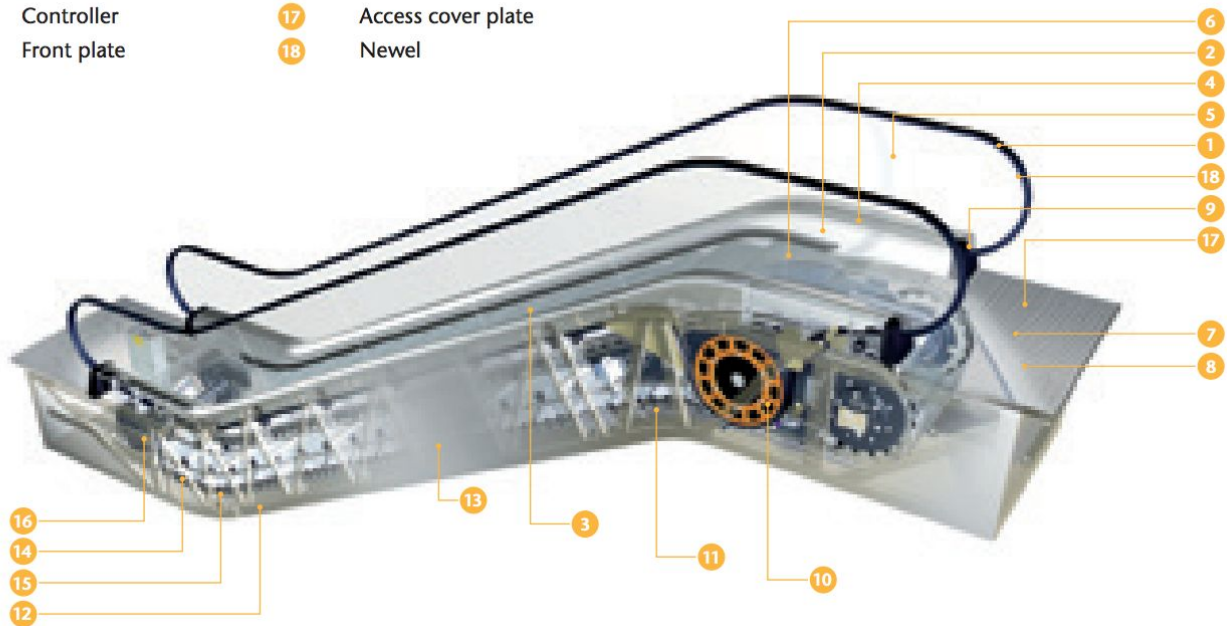


Diagram 6.20 Multi-Level Parallel Arrangement of escalators at Summit Mall

6.3.2 Components of Escalators

Item	Component	Item	Component
1	Handrail	10	Handrail drive
2	Skirting	11	Transition radii
3	Steps/pallets	12	Truss
4	Decking	13	Side cladding
5	Balustrade	14	Step chain
6	Horizontal steps/pallets	15	Tracks
7	Drive station	16	Return station
8	Controller	17	Access cover plate
9	Front plate	18	Newel



6.3.2.1 Upper and Lower Landing Platforms

These two platforms house the curved sections of the tracks, including the gears and motors that drive the stairs. The top platform contains the motor assembly and the main drive gear, while the bottom holds the step return idler sprockets. These sections also anchor the ends of the escalator truss.

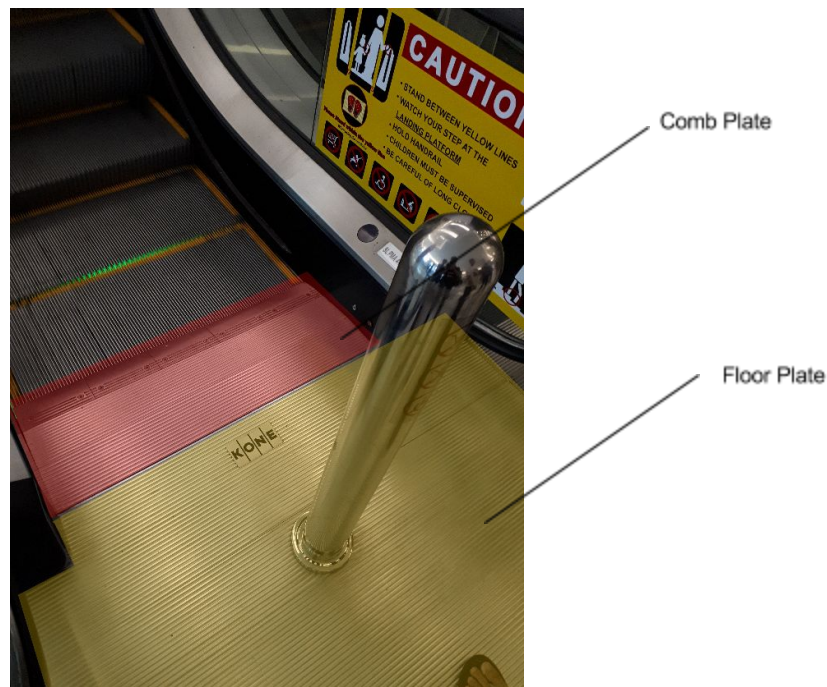


Diagram 6.21 *Floor Plate and Comb Plate of escalator*

Each of the platforms contain a floor plate and a comb plate. The floor plate provides a place for the passengers to stand before they step onto the moving stairs. This plate is flush with the finished floor and is removable to allow easy access to the machinery below. The comb plate is the piece between the stationary floor plate and the moving step. It is so named because its edge has a series of cleats that resemble the teeth of a comb. These teeth mesh with matching cleats on the edges of the steps. This design is necessary to minimize the gap between the stair and the landing, which helps prevent objects from getting caught in the gap.

6.3.2.2 Escalator Truss

An escalator truss is the structural frame of an escalator which consists of, the lower section, incline section and the upper section. It is a hollow metal structure that connects the lower and upper landings. Both ends of the elevator truss are attached to the top and bottom landing platforms through steel or concrete supports. The structural steel truss members are designed to carry the entire load of the escalator equipment and the steel covering. To maintain close operating tolerances, the entire structure must rigid enough but at the same time tolerating building shift and vibration because of a built-in system of shift- plates and Teflon pads.

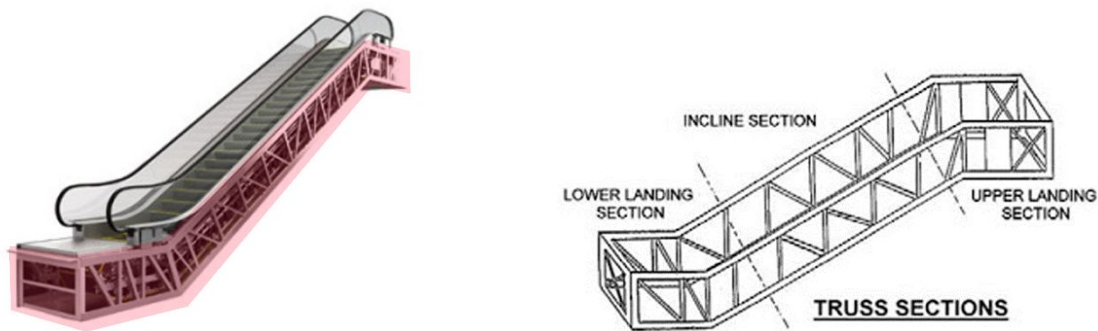


Diagram 6.22 Elevator truss connected to the platforms at both ends

6.3.2.3 Escalator Tracks

The track system is assembled into the truss of escalator to guide the step chain, which endlessly pulls the steps from the bottom platform to the top platform in an endless loop. The track system carries the steps down along the bottom of the truss until they reach the bottom landing, where they pass through another curved section of track before departing from the bottom landing. At this point, the tracks separate and the steps once again assume a staircase configuration. This configuration forces the back of one step to be at a 90-degree angle relative to the step behind it. This right angle bends the steps into a shape resembling a staircase. This cycle is repeated continuously.

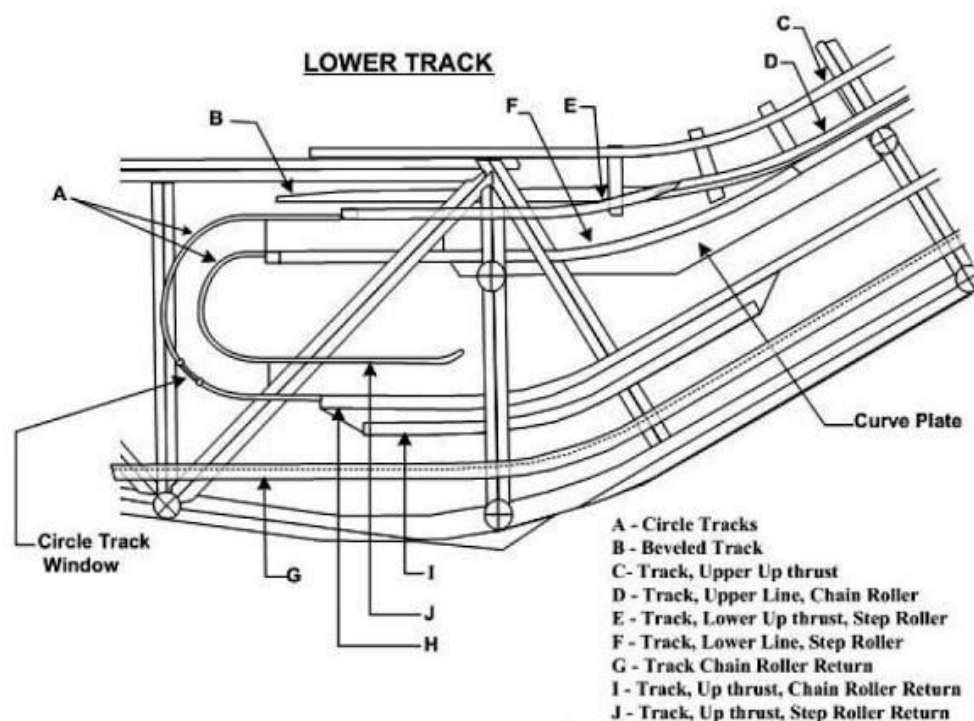


Diagram 6.23 Components of an Escalator Track

6.3.2.4 Escalator Steps

The escalator steps are an arrangement of solid, one piece, die-cast aluminum or steel steps. The steps are linked by a continuous metal chain that forms a closed loop. The front and back edges of the steps are connected to a pair of wheels each. The front wheels have shorter axles to fit into the narrower front track whereas the rear wheels are set further apart to fit into the back track. Normally, yellow demarcation lines may be added to clearly indicate the steps edges.

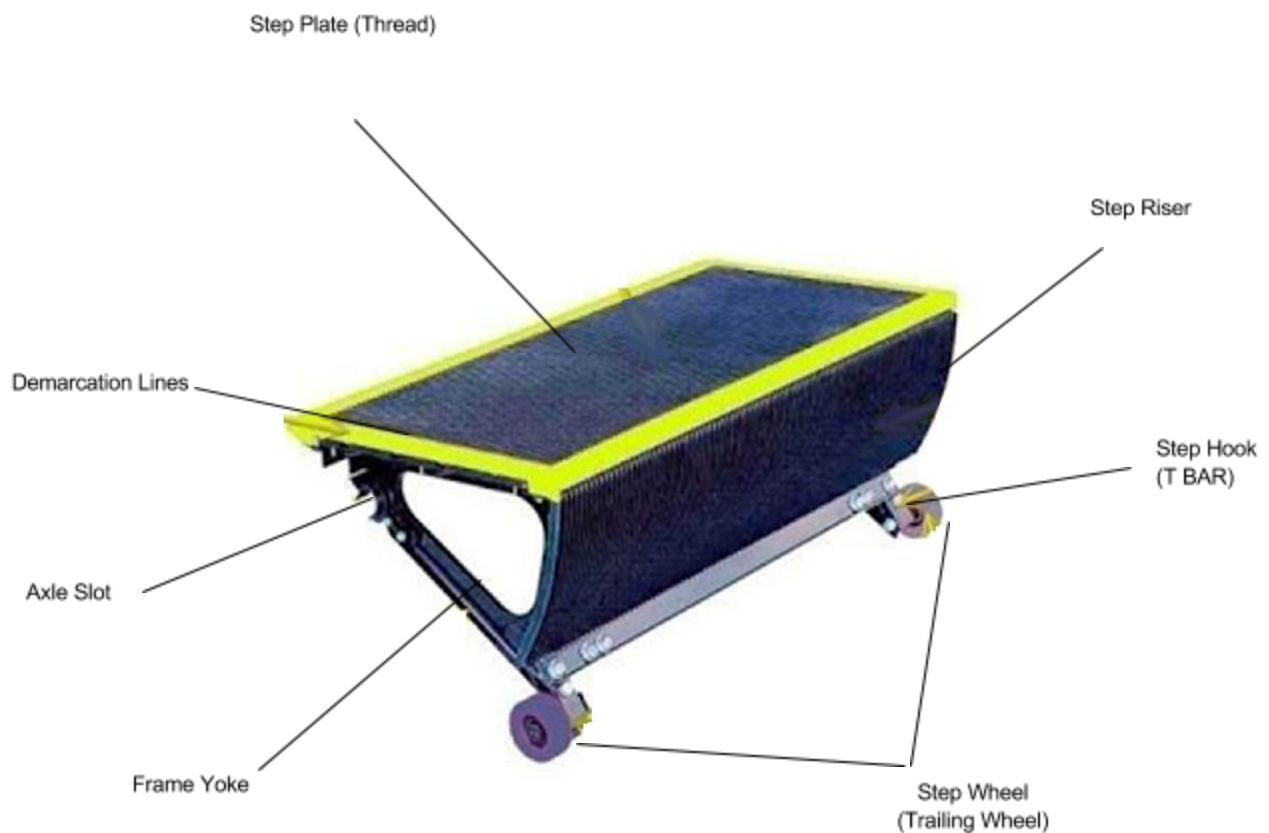


Diagram 6.24 *Components within an escalator step*

6.3.2.5 Handrail

A Handrail on the escalators provides a convenient handhold for the users while they are get onto the escalator. In an escalator, the handrail is drawn along its track by a chain that is connected to the main drive gear by a series of pulley.

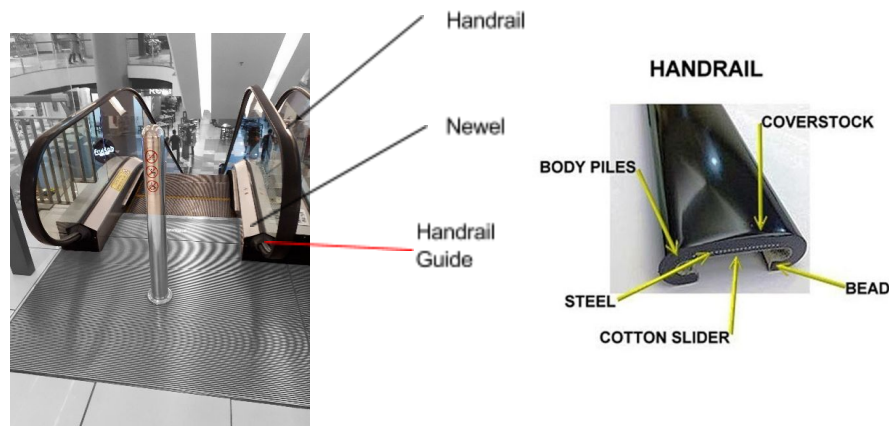


Diagram 6.25 Components within the handrails

6.3.2.6 Escalator Balustrade

A Balustrade consists of the handrail and the exterior supporting structure of the escalator. The balustrade can also refer to the skirt panels, individual interior panels, and deck covers of the escalator. Each interior balustrade panel section is removable to allow ease of access towards the escalator interior for maintenance and component replacement.

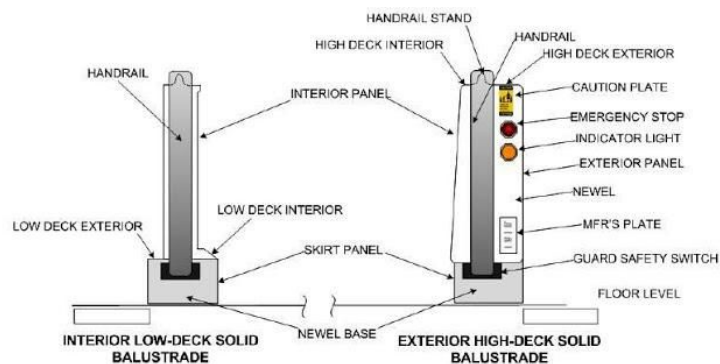


Diagram 6.26 Front elevation of Escalator balustrade and its components

6.3.2.7 Internal Drive Machine

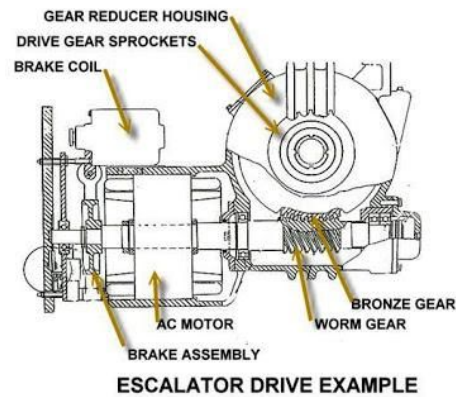


Diagram 6.27 View of an Internal Drive Machine used in escalator (Left) Components within an Internal Drive Machine(Right)

A Drive Machine is used in escalator to drive the pinion gear or the main drive chain which may directly or indirectly drive the Handrail Drive System. In summit USJ, elevators with Internal Drive machine is installed. The machine is located at the upper landing, installed inside the truss between the step bands or at the top pit, the machine will employ a motor to gearbox drive with a direct drive axle connection. Normally in an Internal Drive Machine, a separated dual drive machine within the step band is not uncommon with one machine used to directly drive the step chains located a few feet below the upper incline and one above the lower incline.

6.3.2.8 Braking Systems

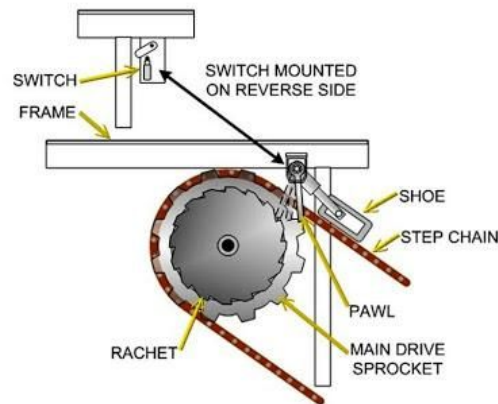


Diagram 6.28 *Components within the Brake system of Escalator*

The braking system uses a pawl connected to one end of the main drive shaft to engage a notch wheel with brake linings on both faces. The brake lining wheel is slotted between the handrail 1st drive sprocket and the step chain sprocket. A guide shoe lever is connected onto the opposite end of the main drive shaft. It is normally supported by the drive chain and when the chain breaks, the shoe drops and turns the shaft. The drive shaft brake pawl moves into the ratchet wheel and stops the escalator when the guide shoe drops.

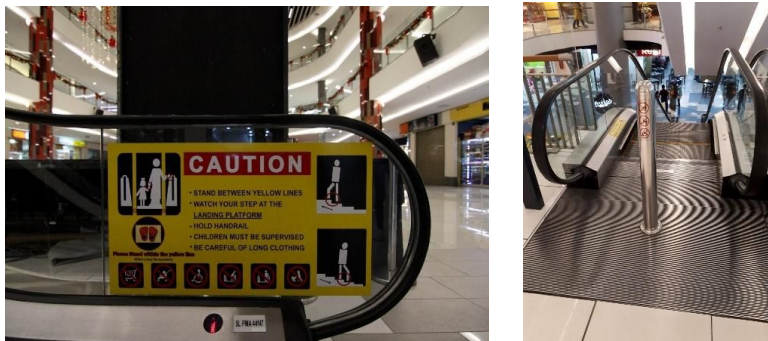
6.3.2.9 Safety Devices

(i) Emergency Stop Button (E-STOP)

An emergency stop button is provided at both the upper and lower landing of the escalator. This covered button enables anyone to stop the escalator immediately in the event of an emergency. Lifting the cover of the emergency stop button will trigger an alarm for five minutes or until the escalator is restarted. To restart an elevator, release the Emergency Stop Button by using the normal start-up procedure.



(ii) Caution Sign Boards & LED indicator



Caution sign boards can be found at the glass panel of the top and bottom landing of every escalator at Summit Mall which must be noticeable by the users. The signs are in standard format with identical size, wording and colors. On the other hand, green and red LED lights are provided at the escalators to inform the users whether the escalators are going up or down.

6.4 Inclined Travelator

An Inclined travelator is a slow-moving conveyor mechanism that transports people or goods across an inclined plane over a short to medium distance. Inclined travelators are usually provided in shopping malls where shopping carts or trolleys need to be transported to different levels. By transporting people continuously non-stop, travelators ensure smooth flow of people through the building and has the capacity to handle high traffic. Summit Mall in USJ uses KONE Inclined Travelators. The Inclined travelators in Summit are located next to Giant Mart to provide an easy access to basement floors after shopping. It allows the users to bring their shopping trolleys to their cars at basement levels.



Diagram 6.29 Travelator located at the lower ground floor for transportation of goods to the basement



Diagram 6.30 Dimensions of Travelator used in Summit USJ

6.4.1 Safety equipment

(i) Handrail and Headroom Clearance

In Summit Mall USJ, the measurement for headroom measured vertically from the step nose line and landing plates is 2500 mm which fulfilled the minimum requirement. The distance between handrail and adjacent surfaces such as columns in Summit is 400mm. It is to ensure passengers are free from any potential risk such as knocking some harmful object hence causing any injuries.

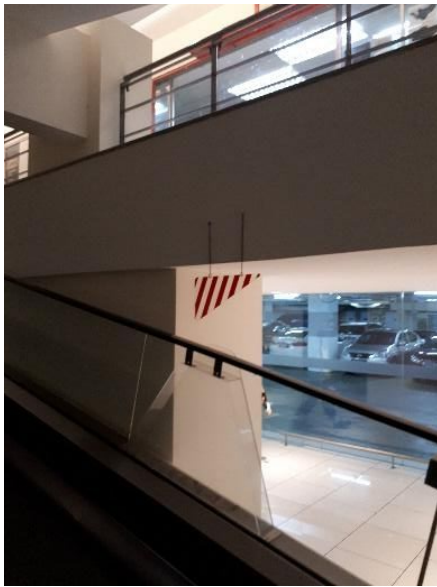
(ii) Protective Barriers

Suitable structural measures are installed at the both ends of the inclined travelators to prevent people from taking rides in between the escalators. These protective barriers act as guards that are provided on the balustrading of travelator wherever necessary.



Diagram 6.31 *Anti-Slide device installed to avoid sliding of objects or people*

(iii) Head Guards



These head guards, known as apex guard's aids in the safety requirement of travelators, preventing passengers' heads getting trapped in between the balustrade and the building structure. This might cause unwanted accident in the mall.

Diagram 6.32 Head guards with striking red stripes

(iv) Emergency Stop Device



The emergency stop device is provided at both the upper and lower landing of the Travelator. This covered button enables users to stop the travelator immediately in the event of an emergency.

Diagram 6.33 Emergency Stop Device installed at the side of handrails to ease user triggering the brakes