3.0 Mechanical Ventilation

3.1 Introduction

3.1.1 Ventilation

It is defined as the provision of fresh air into a room or a building, also known as the process of changing air in an enclosed space. It usually happen between the internal air and the external air of a building.

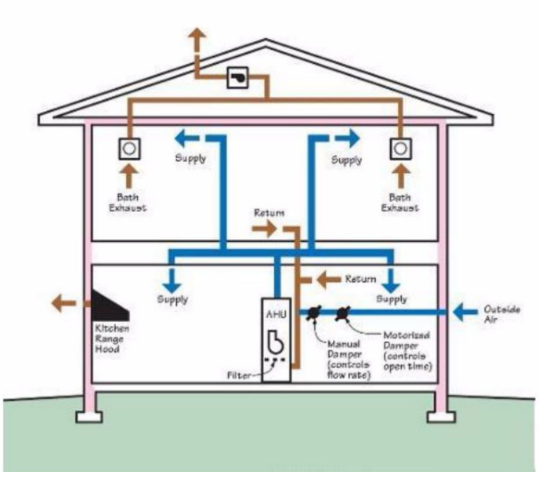

Diagram 3.1: *Diagram above shows one of the example of mechanical ventilation system.*

Natural Ventilation	**Mechanical Ventilation**
• Process of supplying and removing air through an indoor space by natural means. • Uses outdoor air flow caused by pressure differences between the building and its surrounding.	• Process of replacing air by removing internal air and supplying fresh air in a space with the use of mechanical devices. • Supply of fresh air is through ductwork or fans.

3.1.2 Mechanical Ventilation System

It's a type of ventilation system which uses the mechanical devices to keep fresh air circulating in an internal space and also one of the services system introduced to help in maintaining a certain level of comfort in an internal space. This system functions incorporating the usage of mechanical devices like the fans and ductwork to circulate the air throughout a building envelope. Mechanical system does the job of heating, cooling and maintaining the humidity level of a space. Regular inspection and maintenance is often needed to keep this system operating well.

In commercial developments, mechanical ventilation is typically driven by air handling units (AHU) connected to ductwork within the building that supplies air to and extracts air from the interior. Typically they comprise an insulated box that forms the housing for; filter racks or chambers, a fan (or blower), and sometimes heating elements, cooling elements, sound attenuators and dampers. In some situations, such as in swimming pools, air handling units might include dehumidification.

3.1.3 Functions of Mechanical Ventilation System

Removal of pollutants	Fresh air supply	Circulation of air
• It helps to get rid of the contaminated stale air while extracting the internal air out from a space.	• It constantly draws in external air that's less polluted and less water vapor into the internal space when its operating.	• It keeps the circulation of air on going throughout the internal space with the pressure difference created by the devices involved.

3.1.4 Comparison of Mechanical Ventilation System to Natural Ventilation

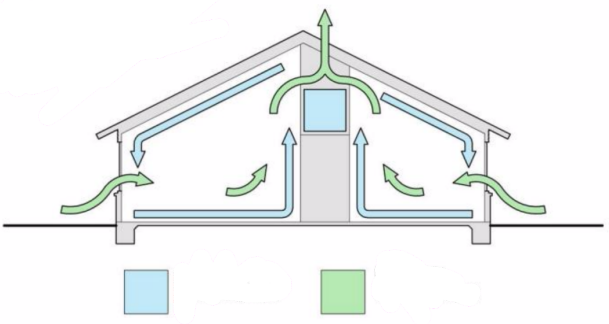

Diagram 3.2 *Schematic diagram above shows the use of natural ventilation and also mechanical system in a house building*

Mechanical Ventilation	Natural Ventilation
Provide fresh air into space with help of mechanical devices	Through the use of openings like windows, doors.
Maintenance needed	Maintenance NOT needed
Operates on electricity and human supervision	Happens naturally and uncertainty
Ventilation can be done all the time	Ventilation is done periodically based on weather and nature restrictions
Use of mechanical devices	Rely on building envelope
Time used can be controlled	Free and not controllable

3.1.5 Advantages and Importance of Mechanical Ventilation System

1. It helps to reduce noise and air pollution when big openings are not encouraged for natural ventilation in a building located at congested and busy area.
2. Its controllable as it can be switch on or off depends on situation or the user's need.
3. It helps to maintain the internal humidity of a space or building regardless of the outdoor weather.
4. It helps to preserve the content of fresh air circulating in a building.
5. It helps to disperse the concentration of bacteria.

3.1.6 Types of Mechanical Ventilation System:

3.1.6.1 Supply Ventilation System

Supply system frameworks utilize a fan to pressurize the building, forcing outside air into the building while air spills out of the working through openings in the shell, shower, and range fan channels.

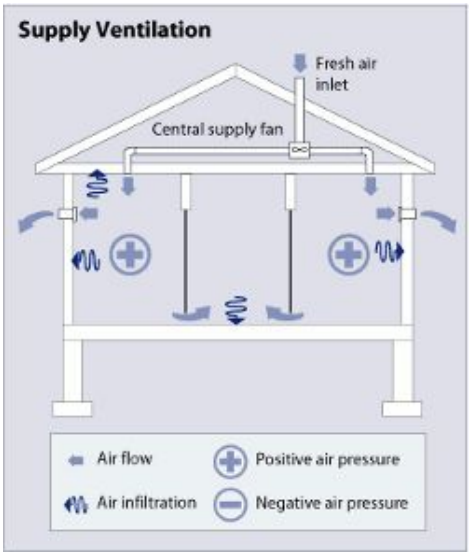

Diagram 3.3: *Schematic Diagram above shows how the air is drew into the house though the central supply fan, the positive air pressure in the internal space forces the air to flow out through the opening of the building envelope.*

The inlet is normally placed or installed at the rooftop to encourage air from the upper level to be drawn in, it should not be located too close to the outlet to prevent the escape of air. The incoming air can be filtered before being directed into the internal rooms.

This system can usually be found in use in areas like living spaces, public malls and interior rooms of a building. The advantages of this positive pressure created in the internal space also help to guard upon radon and other problems caused by negative pressure. Fan or a series of ductwork is used to keep the air circulating the internal space of a building.

3.1.6.2 Exhaust Ventilation System

The exhaust system is also known as fan, it can extract the hot air inside the room and cause a negative pressure on the inlet side which can help to freshen the air to enter to the interior spaces. Mechanical extract fans in windows or roofs and ducted system where the air is to be discharged away from the occupied space owing to its combination with heats. fumes. smoke, water vapour or odour. This system can be used in dwellings. offices, factories or public buildings. A slightly reduction in air static pressure is caused within the building, and external air flow inwards.

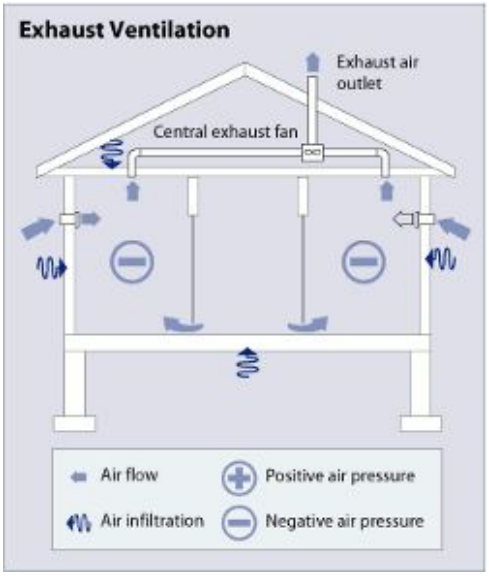

Diagram 3.4: *Schematic Diagram shows the circulation of air in a space with the application of exhaust ventilation system.*

3.1.6.3 Balanced/Combined Ventilation System

Natural Ventilation openings would become unable to cope with large air flow rates without disturbing the architecture or causing uncontrollable draughts. full mechanical control of air movement is assumed. This may augment natural ventilation at times of peak occupancy or solar heat gain. When a building is to be sealed from external environment, then only the air-conditioning system is to be used.

It's a type of ventilation system at which the inlet and outlet are both operating mechanically, which means that the air is supplied in and extracted with the help of mechanical devices. Hence, causing the pressure level in the internal space to remain at neutral.

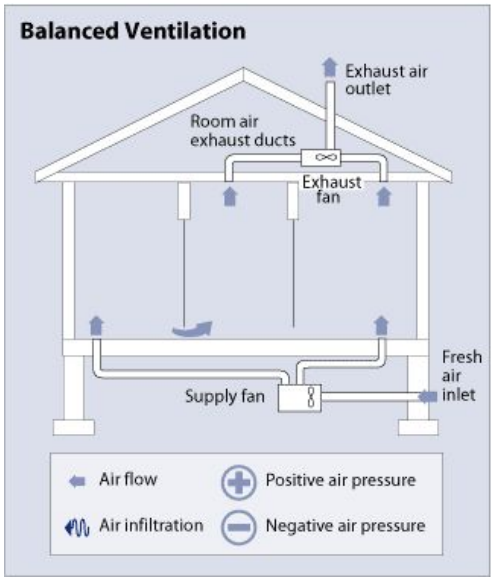

Diagram 3.5: *Schematic Diagram shows the operation of the balanced ventilation system in a budding.*

The internal space of a building can be ventilated with the use of two different sets of ductwork and also fan system. It's not affected by the outdoor weather and is known as a more efficient ventilation system. The extract fan used is usually slightly smaller than the inlet fan to create a slight pressurization of the air inside the building to prevent dust, draughts and noises. The ventilation can be done at multiple points at which the house pressure is also balanced. Its often found in area that is hardly accessible where natural ventilation is not easily promoted and applied. For example, the basement, theatres and crawl

spaces. One positive side about this system is it has a controlled air flow rates, inlet air can also be filtered before being directed to the interior spaces.

3.1.7 Comparison of Supply System, Exhaust System and Balanced System

Ventilation system	Advantages	Disadvantages
Supply ventilation system	• Simple and inexpensive to install. • Allows better control of the air entering the house. • Minimize outdoor pollutants in the internal living space as incoming air can be filtered.	• Can cause moisture problem in cold area. • Does not remove moisture from the incoming air.
Exhaust ventilation system	• Appropriate for cold climates. • Simple system and easily to be installed. • Prevents moisture into the internal spaces.	• Not appropriate for hot climates. • Can draw in pollutants into internal space. • Cause noises.
Balanced ventilation system	• No pressurization in internal space. Allows the use of filter to remove dust and pollen from outside air. • Appropriate for all climates.	• Expensive installation as it requires two sets of ductwork and fans. • Will not temper and remove moisture from incoming air.

3.2 Mechanical Ventilation System

Summit Mall USJ is a large shopping centre of 6 floors which consists of individual shop unit that serve mostly to retailing. Due to spatial planning of having separated shop units, each of the unit has their own ventilation system installed. The shop units are all attached to one another hence inlet and outlet for natural ventilation are not encouraged, at this point mechanical ventilation system plays an important role to keep the interior spaces of the building comfortable and safe for the users. The main mechanical ventilation system that has been used in Summit Mall, is centralized air-conditioning system. Centralised air-conditioning system is a process of removing heat content from multiple sources in the building through a series of heat exchange equipment which ultimately remove the heat to the outdoor atmosphere. This process involves the application of chiller, water pump units and cooling tower as shown below.

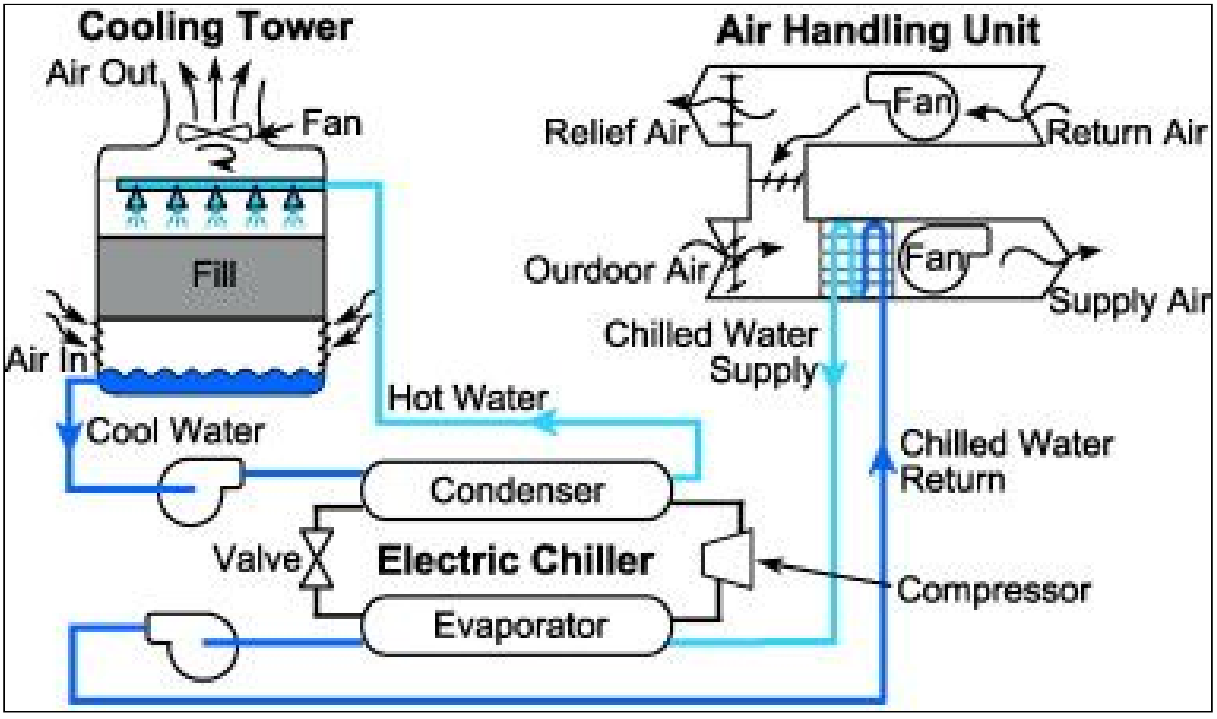

Diagram 3.6: *Centralized Air-Conditioning System*

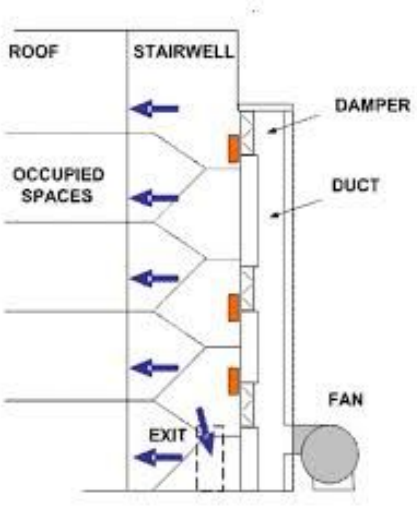

Diagram 3.7: *Schematic diagram above shows the sedan of a typical pressurized system stairwell, (As similar to Summit USJ)*

Summit USJ feature as a commercial building led to the use of many staircases as alternative route and also as fire escape route for the occupants. This system is applied in the stairwell in Summit USJ by having the air constantly supplied into the space through a central fan, pressure relief damper is installed at each level to help reducing the pressure. The pressure reduces when the fire rated door is pushed open.

Uniform Building By-Laws 1984	Analysis
Section 202: **<u>Pressurized system for staircases.</u>** All staircases serving buildings of more than 45 meters in height where there is no adequate ventilation are required shall be provided with staircase pressurization system designed and installed in accordance with MS 1472. Ventilation for staircase at each floor or landing with a minimum of 1sqm opening	The supply fan is switched on 24 hours to maintain the pressure in the stairwell. It is switched on for it to perform in case fire or emergency occurs.

per floor. In building less than 3 storeys, staircase may not be ventilated if access via ventilated lobbies at all floors except the top most and; if building 18m high or less with top most floor ventilated at top most with 5% of area of enclosure. Building higher than 18m to be mechanically ventilated if not naturally ventilated at every floor or landing.	

Diagram 3.8: *The photo on the left are the fire rated doors at each level of the building.*

The door will affect the pressure and causes it to drop when opened, sufficient air supply is needed to ensure the pressure remains as same to prevent the entry of smoke.

Diagram 3.9: *The photo on the loft shows the pressure relief damper installed on the wall near to the staircases.*

3.3 Exhaust ventilation system

3.3.1 Smoke Spill Fan

In Summit USJ, it is a commercial building that host more than 100 of shop units. The shop units are all attached to one another and it doesn't allow openings and fenestrations to be made at too many sides, due to this issue exhaust ventilation system is applied in each of the shop unit to ensure the quality of internal air in each unit. Some of the restaurants use a more complex and advanced exhaust system in order to remove the stale air from the kitchen and public toilets.

Diagram 3.10: *The photo on the left shows the rooftop of the building. A series of ductwork can be spotted connecting out to the rooftop.*

Due to its function as commercial building, the exhaust system applied is not centralized but is made individually depending on the shop's usage.

Diagram 3.11: *The photo shows the exhaust vent lat on system used by one of the unit which serves the purpose as a restaurant in Summit USJ.*

Shops with usage as restaurants has a more complex exhaust system that helps to remove the heat produced from cooking activities in the kitchen. The exhaust ductwork opening is connecting all the way up to the roof where the exhaust fan would be placed.

Uniform Building By-Laws 1984	Analysis
Section 99 **<u>Cooking facilities in residential building</u>** 2) Where a common vertical kitchen exhaust riser is provided, the riser shall be continued up to a mechanical floor or roof for discharge to the open. and shall be constructed with fire resisting material of at least 2 hours rating with BS476: Part 3.	Most of the ventilation system in this commercial building function mechanically, they rely highly or exhaust grille arc fan system in order to expel the stale air from the internal spaces as natural ventilations rot encouraged in such a packed area. The arrangement of ductwork is in order and tore systematically to ensure highest efficiency of the dispersal of contaminated air. The exhaust ventilation system applied is more on traditional method which only one or two outlet are involved in withdrawing the stale air.

Conclusion

As a conclusion, Summit Mall chosen the right chosen of using the centralized air-conditioning system as the large scale of the commercial shopping space required a systematic air circulation system. Thus, it is appropriate. However the air conditioning system in the shopping mall is already quite run down, as the system practices are the old system have been used since 1999.

The components of the air-conditioning system such as AHU, Chiller Plant Room and Cooling Tower were placed at the appropriate area. And this allows the system to run smoothly and do energy saving at the same time concerning bout the environment benefit.

The building complies with the by-law in terms of air distribution, off- hour control and temperature control, which is maintain about 23 °C. Last but not least, the air conditioning system has provide sufficient of thermal control for the interior spaces of the building especially the high density area. But there are minimal of air movement at the low density area, which do not comfort users at all.

4.1.5 Types of mechanical ventilation system:

4.1.5.1 Supply ventilation system It is a system which the fresh air is drew in with the use of mechanical inlet and then the internal air is withdrew through the existing openings in a building envelope naturally. It involves the use of fan to bring the air from the outside into the internal space, the air flew out through holes, fan ducts and vents. It's usually used to supply fresh air into one room or more than that.

Supply Ventilation

• Air flow 0 Positive air pressure Alr infiltration 0 Negative air pressure

Figure 4.1.3: Schematic Diagram above shows how the air is drew into the house though the central supply fan, the positive air pressure in the internal space forces the air to flow out through the opening of the building envelope. Source: ("Whole-House Ventilation I Department of Energy, 2016)

4.1 Mechanical Ventilation System (Literature Review) 4.1.1 Introduction 4.1.1.1 Ventilation
It is defined as the provision of fresh air into a room or a building, also known as the process of changing air in an enclosed space. It usually happen between the internal air and the external air of a building.

Ventilation

Natural Ventilation

Mechanical Ventilation

• Process of supplying and removing air through an indoor space by natural means. • Uses outdoor air flow caused by pressure differences between the building and its surrounding.

• Process of replacing air by removing internal air and supplying fresh air in a space with the use of mechanical devices. • Supply of fresh air is through ductwork or fans.

4.1.1.2 Mechanical Ventilation System
It's a sort of ventilation framework which utilizes the mechanical gadgets to keep outside air flowing in an inward space and furthermore one of the administrations framework acquainted with help in keeping up a specific level of solace in an inner space. This framework capacities joining the utilization of mechanical gadgets like the fans and ventilation work to flow the air all through a building envelope. Mechanical framework does the employment of warming, cooling and keeping up the dampness level of a space. Consistent examination and support is frequently expected to keep this framework working great.

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Figure 4.1.1 Diagram above shows one of the example of mechanical ventilation system. Source: ("Ventilation, Home Pride Contractors ", 2016)

4.1.2 Functions of mechanical ventilation system

Removal of pollutants

Fresh air supply

Circulation of air

• It helps to get rid of the contaminated stale air while extracting the internal air out from a space.

• It constantly draws in external air that's less polluted and less water vapor into the internal space when it's operating.

• It keeps the circulation of air on going throughout the internal space with the pressure difference created by the devices involved.

Components of the Mechanical Ventilation Found in Summit Mall USJ:

- Chilled Water Plant
- Air Handling Unit and Fan Coil Unit
- Cooling Tower
- Evaporator
- Condenser
- Compressor
- Ductwork and Pipe System
- Refrigerant
- Supply and extract system
- Cooling Coil
- Air Filter

Ventilation is a necessity in a building to remove any ‘stale’ air while replacing it with ‘fresh’ air. In most cases, ventilation covers in moderating temperature by creating air movement which improves the comfort of occupants. The type of ventilation system can be broadly classified into two type, ‘natural’ and ‘mechanical’ ventilation. Mechanical ventilation tends to be driven by fans whereas natural ventilation relies on natural pressure differences from one part of the building to another. Natural ventilation can be either wind-driven or buoyancy-driven such as Stack effect and Cross Ventilation. However, Summit Mall USJ relies mostly on mechanical ventilation to control the air quality, air humidity and air temperature in a building by using mechanical components such as fans, air conditioners and others. The design of a mechanical ventilation system is generally a specialist in a certain task, undertaken by a building services engineer. Whilst there are standards and rules of thumb that can be used to determine air flow rates for straight-forward situations, when mechanical ventilation is combined with heating, cooling, humidity control and the interaction with natural ventilation, thermal mass and solar gain, the situation can become complicated. Noise generated by fans and the impact of ductwork on acoustic separation are some of the many complications that comes along with mechanical ventilation. Hence with so many components, mechanical ventilation is normally used in a bigger scale building like shopping mall.