Discussion Paper
6 May 2011

Legislative Council Panel on Transport

Subcommittee on Matters Relating to Railways

Functions of Ventilation Facilities for Railway System

Purpose

In the consultation activities on the new underground railway system in the past few years, members of the public has raised concern on the design of the ventilation facilities of railway system, especially ventilation facilities located at road level. This paper briefs Members on the functions and design considerations of ventilation facilities for an underground railway system.

Needs for Ventilation in Underground Railways

2. Continual air circulation is required within the stations and tunnels so as to maintain the air quality and temperature for a safe operation of the railway. Being at the sub-tropical latitude, the temperatures of soils and rocks in Hong Kong are relatively high compared to those at locations with cooler climates. The heat sink effect by the soils and rocks is therefore not significant to absorb the waste heat generated by the railway system.

3. During normal operation, the ventilation facilities bring fresh air to stations and trains underground, and remove the heat and moisture generated by passengers and railway equipment. It is not a pollutant exhaust system. MTR trains are powered by electricity and do not generate any emission. Some members of the public are concerned about the impact on air quality due to the presence of railway ventilation facilities despite that the exhaust from the MTR ventilation openings does not contain any undesired emissions or pollutants. The MTR Corporation Limited (MTRCL) has installed dust monitoring devices at a ventilation opening at Central Station to monitor the air quality. The data recorded by the devices is similar to

those recorded at the roadside air monitoring point installed nearby by the Environmental Protection Department. It demonstrates that the exhaust from the ventilation facilities has no impact to the surrounding. The MTRCL will further implement promotions to enhance public understandings on the functions of ventilation facilities. The MTRCL will also maintain close communication with the residents nearby so as to alleviate their concern.

4. The configuration of the ventilation system for the underground railway system in Hong Kong has been designed to serve three separate zones, namely Tunnels, Trackways and Stations. The ventilation facilities required for each underground station are summarized below:-

(a) two ventilation openings at each station end for tunnel ventilation;
(b) two ventilation openings at each station end for trackway ventilation;
(c) two ventilation openings at each station end for station ventilation; and
(d) a heat removal system at each station for chiller heat removal.

The functions of each group of these ventilation facilities are detailed in **the Annex**.

Annex

5. Apart from function of air ventilation, all ventilation facilities in the railway system are part of the emergency air circulation system which is a crucial component of the railway emergency safety system. Under an emergency situation, the ventilation facilities provide adequate air circulation and maintain the safe environment in underground stations, trackways and tunnels. Although it is very rare to have a fire in the underground railway system, the ventilation openings will allow the discharge of smoke in the event of a fire and hence protect passengers.

Design Constraints for Ventilation Facilities

6. It is a statutory requirement that all ventilation openings are required to be at least 5m away from buildings nearby and at least 3m above the pedestrian level. It is also required to comply with the Noise Control

Ordinance and the statutory codes of the Fire Services Department, which specify the design requirements against flooding and minimizing the nuisance to adjoining properties, pedestrian or traffic.

7. The underground railway system in Hong Kong, including the ventilation facilities, is required to design for surface flooding. Ventilation openings must be raised above the possible flood level to avoid uncontrolled water ingress to the underground railway system. In addition to the height requirement, the orientation and the size of ventilation openings shall be designed to avoid creation of nuisance to adjoining properties, pedestrian or traffic. The design criteria in Mainland and overseas cities[1] generally require the openings of newly designed ventilation shafts to be at certain heights above ground.

8. The location of ventilation facilities, land take for ventilation facilities and acoustic level at ventilation openings are interdependent. Great effort has been exercised in our railway design to minimise the land take for ventilation facilities. However, having noted the practical needs for maintaining the air quality of the railway system, upholding the passenger safety in emergency, satisfying statutory requirements as stated in paragraph 6 and ensuring flood protection as mentioned in paragraph 7, the design of ventilation facilities has to cope with numerous constraints as follows:

(a) to have an efficient ventilation system, ventilation openings shall be located within 200m radius from stations;
(b) inlets and outlets of ventilation facilities need to be separated by at least 5m such that the warmer exhausted air will not be drawn back into the system reducing the cooling efficiency;
(c) the size of ventilation openings needs to correspond to the anticipated maximum air velocity inside the ventilation system. Too small in the size of the ventilation opening increases the speed of air flow in the system and thus induces higher noise level;
(d) ventilation openings shall not be located too far from the fans;

[1] The design guidelines in London, UK require that the height of a railway ventilation opening should not be less than 2.5m above ground. The administration of Singapore prohibits at-grade ventilation shafts, and requires the height of a ventilation opening to be not less than 2m above ground. The requirement in China also specify the height of a ventilation opening to be not less than 2m above ground.

otherwise additional fans or more powerful fans will be required to drive the air movement which will generate a louder noise.

9. From previous public consultation activities on railway planning and design, there are public concerns over the location, number, land take, size and visual impact of ventilation openings. We understand this concern. Therefore, the MTRCL will take public concerns and suggestions into account in the design of the ventilation facilities in order to reduce their impact on nearby stakeholders, while adhering to the above-mentioned design requirements to ensure ventilation facilities will perform their critical functions.

Visual Treatment of Ventilation Facilities

10. Station ventilation facilities are parts of the urban fabric. The MTRCL will design the facilities from an aesthetic and visual viewpoint with care and sensitivity. The general approach adopted in Hong Kong in designing railway ventilation facilities in recent years is as follows:

(a) every ventilation shaft is critically reviewed to ensure that it is essential and is as small as technically feasible. Ventilation openings are also located away from residential buildings and schools as far as practicable. However, there are certain engineering and environmental limitations in reducing the size of ventilation facilities and therefore a delicate balance has to be reached.

(b) ventilation facilities are integrated with above ground structures such as station entrances or adjacent buildings wherever possible. For instance, the ventilation facilities of MTR Sheung Wan Station of the Island Line are designed to blend in with the Western Market (see **Figure 1**); the ventilation facilities of MTR Admiralty Station of the Island Line are also integrated with the pavilion and the landscape outside the entrance of Three Pacific Place (see **Figure 2**). Endeavours will also be made to make the appearance of ventilation openings less conspicuous so that they do not affect the cityscape. MTR LOHAS Park Station of the Tseung Kwan O

Figure 1

Figure 2

Line is an example of the integration of ventilation facilities and station entrance (see **Figure 3**).

Figure 3

(c) in situations when standalone ventilation facilities are unavoidable, each individual or each group of ventilation facilities is carefully designed to give it an appropriate architectural quality and presence corresponding to its particular urban context. There are various generic visual treatments of ventilation facilities:

i. planting trees around the ventilation facilities or concealing the ventilation facilities with landscape mounds if there is sufficient space. Where space is insufficient around the ventilation facilities for planting, the use of green wall design will also be considered.

ii. providing ventilation facilities with another function or visual identity, for example an artwork or a clock tower, where ample space is available. In Paternoster Square, London, a ventilation structure is designed as a public artwork where there is sufficient open space (see **Figure 4**). As revealed from overseas experience, this kind of treatment is welcome by the public. MTRCL will adopt this approach where situation permits.

Figure 4

iii. improving the appearance of ventilation openings by replacing traditional metal louvers with other architectural treatments such as vertical fins or patterned grille. However, the design shall also be appropriate such that the ventilation function of the facilities is not compromised.

Conclusion

11. We are dedicated to enhancing the design and reducing the visual impact of railway ventilation facilities by introducing green features and designs that blend in with the environment. In the coming railway projects under construction or planning, such as the West Island Line, the Kwun Tong Line Extension, the South Island Line (East), and the Shatin to Central Link, the above visual treatments will be taken into the above considerations in the design of ventilation failicites. Furthermore, references from overseas will

be made where appropriate. We will closely communicate with local stakeholders and listen to their views concerning the design of ventilation facilities for our future railway projects.

Transport and Housing Bureau
MTR Corporation Limited
May 2011

Functions of Ventilation Facilities for Underground Railway System in Hong Kong

Ventilation in Tunnels

1. During normal operation, trains moving in the tunnels push air in front of the train. Due to the piston effect, air is expelled from the tunnel through the ventilation openings ahead, while fresh ambient air is drawn from ventilation openings behind the train. In the design, adequate ventilation in the tunnel can be achieved by the piston effect alone and no supplementary fan is required. It is therefore an energy efficient and sustainable ventilation solution. As such, each tunnel section between two stations requires dedicated ventilation openings at each end.

2. In the event that a train is stayed at the platform for a longer period, any follow-on trains must be halted in the tunnel awaiting the clearance of the platform ahead. Since the train is halted in the tunnel, fresh air cannot be drawn into the tunnel by piston effect. Air temperatures in the tunnels will rise. It is therefore necessary to make supplementary fans available at the ventilation openings at each end of a tunnel section, so that fresh air can be drawn in to maintain the air quality within the tunnel in the event of a prolonged delay of trains at platforms or in tunnels.

3. These supplementary fans are also required in air movement control within the tunnels in the event of an emergency such as a train breakdown, a fire, or other extreme situations requiring evacuation within the tunnels.

Ventilation in Trackways

4. A trackway refers to the tunnel space occupied by a train when train is stopped at a station for boarding and alighting passengers. Once a train is stopped, the piston effect will not work. Other means of facilitating air circulation is required. The design in MTR system is to supply fresh ambient air via ducts located below the platform, directed towards the underside of the train. Air circulation is achieved with an air duct along the trackway on top of the train roof.

5. Typical stations comprise two platforms, each of which needs a supply and extract system for the trackway area, which results in four trackway ventilation shafts per station.

Ventilation in Stations

6. Underground stations in Hong Kong are air-conditioned. A continual exchange of air within the station is required to maintain the air quality without incurring excessive cooling requirements. This ventilation needs to rely on a dedicated station ventilation system. To enhance the ventilation efficiency, two ventilation shafts at each end of station are usually provided in order to minimise energy losses due to excessive duct lengths.

7. The station cooling system requires a heat removal system to cool the chillers. The heat removal system is selected with reference to the station locations such that the most effective cooling performance can be achieved.

Figure 1: Ventilation facilities of MTR Sheung Wan Station of the Island Line are articulated to blend with the adjacent building.
圖一： 港鐵港島線上環站的通風設施與附近建築物融合設計

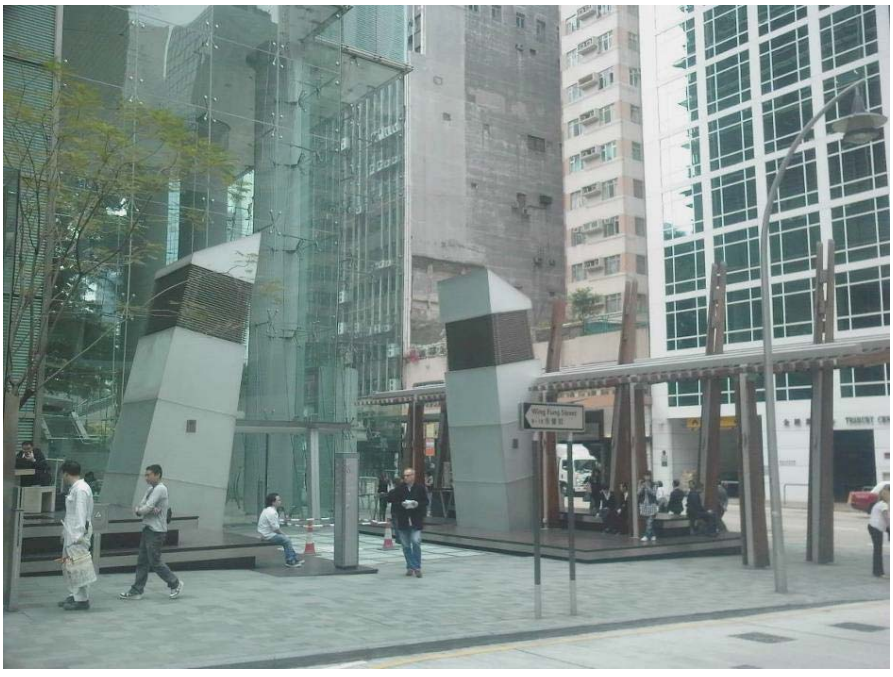

Figure 2: Ventilation facilities of MTR Admiralty Station of the Island Line are integrated with the pavilion and landscape outside the entrance of Three Pacific Place.
圖二： 港鐵港島線金鐘站的通風設施
與太古廣場三期的避雨亭及戶外園景融合設計

Figure 3: Ventilation facilities of MTR LOHAS Park Station of the Tseung Kwan O Line are merged with the station entrance.
圖三： 港鐵將軍澳線康城站的通風設施與車站出入口融為一體

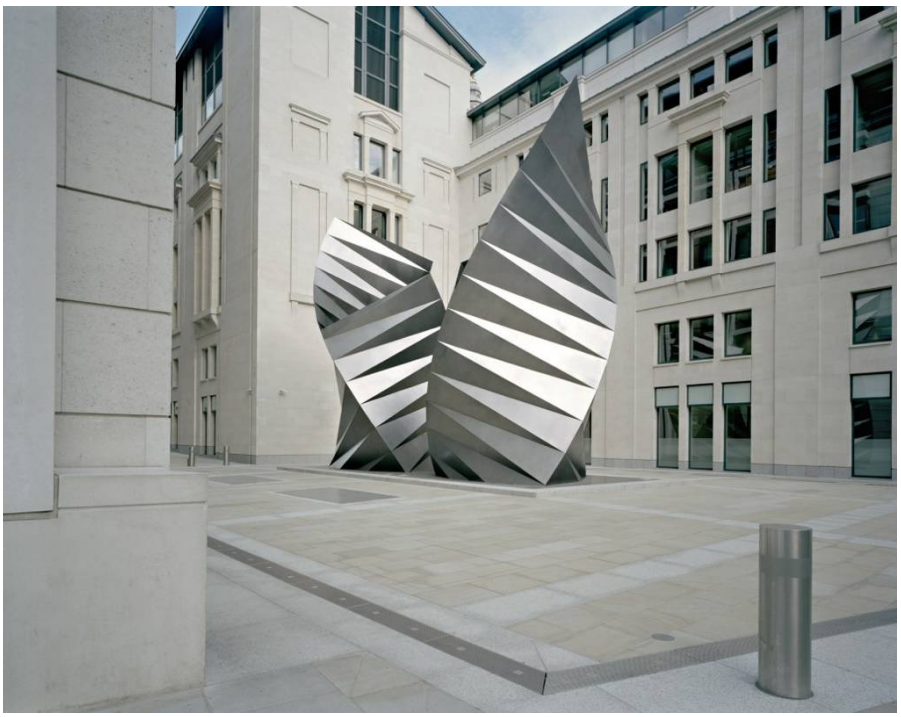

Figure 4: A ventilation structure in Paternoster Square, London is designed as an artwork.
圖四：倫敦帕特諾斯特廣場的通風設施滲入了藝術元素