Legislative Council Panel on Transport
Subcommittee on Matters Relating to Railways

Capacity and Loading of MTR Trains

Purpose

This paper aims to brief Subcommittee Members on the capacity of MTR trains and the initiatives taken and planned for to manage loading in train compartments to enhance comfort and the travelling experience for passengers and to, where possible, increase the carrying capacity.

Background

2. Opened in 1979, the MTR system now consists of 10 heavy rail lines and a Light Rail network in the northwest New Territories. On a normal weekday, an average of 5.2 million passenger trips are made in the 218-kilometre MTR system.

3. A railway line is constructed to meet the transport needs of the population within its catchment area for a projected period of time as well as to ensure passenger safety. Thus, the formulation of the Design Capacity of a railway should meet the demand, while ensuring safety. A railway's carrying capacity is pre-determined by the size of the train compartments and the number of compartments a train comprises. It may be adjusted by the maximum frequency of train services the signalling system permits.

Design Capacity

4. All train compartments of the existing MTR railway lines are designed based on the industry standard design adopted at the time of the construction of railway lines and the maximum carrying capacity of train compartments is calculated based on accommodating up to 6 persons (standing) per square metre ("ppsm") on average. The number of train compartments a train comprises and train frequency are determined at the design stage to meet projected passenger demand. Platform length is designed and constructed accordingly to ensure compatible use of the trains. As to the frequency of train services, it is regulated by the signalling system which governs the distance between operating trains to ensure safety, while maximising efficiency. Increased frequency is made possible through provision of additional trains.

But train frequency reaches its maximum level when the signalling system permits no more additional train trips. The carrying capacity permitted by this maximum train frequency level is the Design Capacity of a railway line.

5. Specifically, Design Capacity of a railway line refers to the maximum number of passengers that can be carried per hour per direction when all the space within the train compartments are taken up by passengers based on a 6 ppsm passenger density level (and all seats are taken up) and train frequencies are maintained at the maximum level its signalling system permits. Accordingly, a train is considered full to Design Capacity when each square metre of standing space of all train compartments of a train carries 6 passengers (and all seats are taken up) and train frequencies are operated at the maximum level. All components of the existing MTR network are designed to be able to underpin this Design Capacity, while remaining safe. This covers, for example, the design of railway station structures, platform size, passageways, and escalator throughput. In other words, the rail services are operating safely even when run at 6 ppsm passenger density[1]. If passenger demand exceeds the Design Capacity, longer queues on platform are expected and more passengers may then need to wait for more than one train before they can board a train. Crowd management measures will be taken to maintain order at the platform and concourse.

Carrying capacity in current operating environment

6. In today's actual railway operation, several key factors impose limitation on the Design Capacity, making the actual carrying capacity less than Design Capacity.

7. First, the retrofitting of platform screen doors ("PSDs") and automatic platform gates on pre-existing rail lines (covering Tsuen Wan Line, Kwun Tong Line and Island Line) has increased the dwell time of trains at each platform by about 10 seconds. As such, it is no longer technically feasible to run the maximum train frequencies these railway lines were designed for.

8. Second, it is not uncommon that train doors may need to be reopened and reclosed due to passengers requiring assistance or objects being caught between doors. Each reopening and reclosing of doors extends the train's dwell time at platform by about 10 seconds. During peak periods on busy lines like

[1] We note that the Design Capacity of railway systems around the world varies, mostly ranging from 4 to 6 ppsm. Yet, very often, these benchmarks cannot be met in practice. For example, metros in Japan have a desirable standard of 3.3 ppsm but currently are achieving an average of 5 ppsm.

Tsuen Wan Line, where train frequency is 2 minutes, every 12 reopening and reclosing of doors within a one-hour period may in effect result in the reduction of one train trip, or reduce carrying capacity by some 2,500 passengers.

9. Third, it has been observed that over the years, passenger riding habits have changed. Nowadays, they are less willing to board a train that looks crowded even when there is still room available. They prefer waiting for the next train. Besides, there is an increasing number of passengers reading newspapers or using mobile devices such as tablet computers or smart phones during their trips that require more personal space on trains. This in effect reduces the carrying capacity of the train and the rail line as a whole. In actual operation, trains running during the busiest hours on the busiest corridors achieve a passenger density of only around 4 ppsm, but 6 ppsm in the 1980s and 1990s.

Initiatives taken to manage loading

Increase in train frequencies

10. The MTR Corporation Limited ("MTRCL") has launched Listening • Responding Programme ("the Programme") starting from 2012. One of the purposes of the Programme is to ease the loading on trains and reduce passenger waiting time. Under the Programme, MTRCL has added more than 1,300 train trips per week (i.e. over 67,000 train trips per year). During the same time, however, the total passenger throughput has increased by almost 3%.

11. The overall loading of the existing railway network during non-peak hours is less than 40% and there is spare carrying capacity to carry more passengers. MTRCL will continue to seek to enhance the frequency of train services in peak and non-peak hours where possible. However, train frequencies on Island Line, Kwun Tong Line, Tsuen Wan Line, Disneyland Resort Line and Airport Express in the morning peak cannot be further enhanced as the current signalling systems are already operating at maximum level. The carrying capacity of these railway lines during peak hours can only be further enhanced by replacing with a more advanced signalling system.

12. MTRCL has begun to upgrade the signalling system for Tsuen Wan Line, Island Line, Kwun Tong Line and Tseung Kwan O Line with a view to boosting carrying capacity and this exercise is expected to be completed from 2018 to 2022. Subsequently, the signalling system for Tung Chung Line,

Disneyland Resort Line and Airport Express will also be upgraded. With the completion of the upgrading of signalling systems, carrying capacity will be increased by around 10%.

13. MTRCL will also arrange short-haul trips running between a few busy stations to increase carrying capacity if a gap between trains under the scheduled train services has opened up to allow safe running of trains. However, these train trips are not always possible and can only reduce passenger waiting time at some stations.

14. Details of carrying capacity and loading of MTR railway lines during morning peak hours on the busiest sections in 2013 are set out at **Annex.** It is noted that the passenger throughput during morning peak for critical links has taken up 25% to 72% of the current carrying capacity (i.e. loading), based on a 6 ppsm passenger density and current train frequency. If the passenger density ratio is lowered to 4 ppsm, the loading during morning peak for critical links will increase to 35% to 100.6%.

Improvement measures implemented

15. It is observed that under normal circumstances, passengers will not uniformly occupy the space on trains. In a single train, compartments closest to escalator landings generally attract more passengers, while those located at the far ends of a platform have relatively fewer passengers.

16. In view of this, MTRCL has implemented the following measures to enhance platform management to even out passenger distribution on platforms and in trains to achieve smoother passenger flow and optimise the efficiency of train operations during peak hours:

(a) barriers are erected at the platforms of key stations to better divert passenger flow to less crowded train compartments;

(b) Platform Assistants are deployed to encourage passengers to move inside trains instead of staying near train doors;

(c) Platform Assistants are deployed to manage the boarding and alighting process to minimise the number of times that train doors have to be reopened and reclosed;

(d) a new queuing arrangement was tried at the Yau Ma Tei-bound platform of Kowloon Tong Station on the Kwun Tong Line in

October 2013. Boarding passengers were guided to line up on the right-hand side of the PSDs while those alighting from trains would exit on the left-hand side. This has facilitated passengers to get on and off trains more quickly and in a more orderly manner. This platform management arrangement is found effective and will continue to be implemented. MTRCL will look into whether such arrangement, with or without modification, can apply to other stations; and

(e) as part of its ongoing efforts to ensure a safe, efficient and high-quality rail service, MTRCL invests some $5 billion every year to maintain its existing railway assets and station facilities at top conditions and upgrade for enhanced service.

Other possible improvement measures

17. Pending the construction and completion of new railway lines (see paragraphs 18 to 21 below), the Government has invited MTRCL to study the feasibility of other measures to enhance carrying capacity. These measures include, for example, an early-bird scheme whereby passengers would be incentivised to use MTR outside peak hours and the removal of some seats in some train compartments, to increase carrying capacity. MTRCL has also commissioned overseas universities to study any other possible measures to relieve the high loading situation during peak hours.

New railway lines to increase network carrying capacity

18. Over the next few years, with the opening of new domestic railway lines now under construction, including the West Island Line by the end of this year to be followed by the South Island Line (East) and Kwun Tong Line Extension in 2015 and Shatin to Central Link ("SCL") in phases in 2018 and 2020, there will be additional carrying capacity and a redistribution of existing passenger flow in the MTR system. SCL, in particular, will increase the carrying capacity of the railway section from Shatin to Kowloon and that of existing lines across the Harbour, thus alleviating the rather high loading situation in urban Kowloon during peak hours. With the commissioning of the section between Tai Wai and Hung Hom stations of SCL in 2018, which forms the East West Corridor[2], the number of train compartments of West Rail Line and Ma On Shan Line will also be increased to 8.

[2] The East West Corridor is a new railway line comprising Ma On Shan Line, West Rail Line and the section between Tai Wai and Hung Hom of SCL.

19. It should be noted that the service level of these four new railway lines is pitched at 4 ppsm service benchmark.

Way forward

20. The Government expects our railway service to be safe, reliable and efficient and MTRCL is committed to providing such quality service. Further efforts will be made to enhance train frequencies where possible through implementation of various measures to smoothening passenger flow and train operations at the busiest stations during peak hours, with a view to providing a most efficient railway service, while ensuring safety.

21. New railway lines now under construction will help increase the overall carrying capacity of the railway network and redistribute passenger flow across the network. In the longer term, consideration will be given to building additional lines or parallel lines to divert passenger flow and to relieve the loading of the existing ones. To this end, the Government is finalising the Review and Update of the "Railway Development Strategy 2000", and will announce the way forward for the new railway projects soon. All new railway lines to be recommended in the new railway development blueprint will use 4 ppsm as the target service benchmark where resources and other relevant factors permit.

22. Whilst railway is the backbone of Hong Kong's public transport network, other public transport modes such as franchised buses, public light buses and taxis will continue to play key roles in our daily public transportation. The various modes together provide comprehensive services and a variety of choices to our community. In tandem with the further development of our railway system, the Government will continue to optimise and rationalise road-based transport services to ensure that the overall public transport network would continue to serve the community efficiently with good quality.

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Annex

2013 Statistics (per hour per direction during morning peak for critical links)

		East Rail Line	West Rail Line	Ma On Shan Line	Tseung Kwan O Line	Island Line	Kwun Tong Line	Tsuen Wan Line	Disneyland Resort Line	Tracks sharing at some sections	
										Tung Chung Line	Airport Express
1.	Design Capacity (6 ppsm) (a)	101,000	64,000	32,000	85,000	85,000	85,000	85,000	10,800	45,000	6,400
2.	Maximum carrying capacity when train frequency is maximised (6 ppsm) (b)	90,000	51,500	30,500	67,500	80,000	71,400	75,000	9,600	45,000	4,800
3.	Existing carrying capacity (6 ppsm) (c)	82,500	49,200	26,800	62,500	80,000	71,400	75,000	9,600	37,500	4,800
4.	Difference between (a) and (b)(Note[1])	11,000	12,500	1,500	17,500	5,000	13,600	10,000	1,200	0	1,600
5.	Difference between (b) and (c)(Note[2])	7,500	2,300	3,700	5,000	0	0	0	0	7,500	0
6.	Current passenger throughput (d)	58,700	34,600	15,200	44,800	52,900	47,600	52,300	2,400	22,400	2,200
7.	Current loading (1) (6 ppsm) [(d)/(c)] { } critical link	71% {Tai Wai to Kowloon Tong}	70% {Kam Sheung Road to Tsuen Wan West}	57% {Che Kung Temple to Tai Wai}	72% {Yau Tong to Quarry Bay}	66% {Tin Hau to Causeway Bay}	67% {Shek Kip Mei to Prince Edward}	70% {Tsim Sha Tsui to Admiralty}	25% {Sunny Bay to Disneyland}	60% {Olympic to Kowloon}	46% {Airport to Tsing Yi}
8.	Current loading (2) (4 ppsm) [(d)/(c)÷71.2%(Note[3])] (For the critical links mentioned in item (7))	100%	99%	80%	100.6%	93%	94%	98%	35%	84%	54%
9.	Current loading (3) (6 ppsm) [(d)/(a)] (For the critical links mentioned in item (7))	58%	54%	48%	53%	62%	56%	62%	22%	50%	34%
10.	Can additional train trips be provided (with the existing signalling system)?(Note[4])	Yes	Yes	Yes	Yes	No	No	No	No	Yes(Note[5])	No(Note[5])
11.	Any plans to upgrade the signalling system? If yes, when will the upgrading exercises be completed?	Yes (to be completed by 2020 when the North South Corridor of Shatin to Central Link (“SCL”) opens)	Yes (to be completed by 2018 when the East West Corridor of SCL opens)	Yes (to be completed by 2018 when the East West Corridor of SCL opens)	Yes (to be completed from 2018 to 2022)	Yes (to be completed from 2018 to 2022)	Yes (to be completed from 2018 to 2022)	Yes (to be completed from 2018 to 2022)	Yes (under planning)	Yes (under planning)	Yes (under planning)

Remarks: The Light Rail is an open system. MTRCL is thus unable to obtain the passenger throughput of each route. MTRCL therefore conducts site surveys to calculate the passenger throughput of Light Rail. The overall loading of Light Rail in 2013 is 88% under 6 ppsm. As the speed and gap between vehicles of Light Rail are manually controlled by train captains and constrained by road traffic and road traffic signals, its service frequency cannot be adjusted by the signalling system, as in the case for heavy rails. Hence, whether additional train trips can be provided does not solely depend on the signalling system of Light Rail. Nevertheless, MTRCL has procured 22 new Light Rail vehicles (“LRVs”) in 2009 and they have all been put into service in 2011. MTRCL is also refurbishing a total of 69 Phase I LRVs to enhance their carrying capacity and improve compartment facilities. As at today, most of these LRVs have been refurbished and they have been put into service after completion of technical and safety tests. MTRCL will continue to refurbish the remaining 50 LRVs (i.e. Phase II and III LRVs). The refurbishment will increase the overall average carrying capacity of the Light Rail fleet by 8%. MTRCL will also continue to flexibly deploy LRVs in response to passenger demand to relieve loading in busy sections and study the feasibility of procuring new LRVs. The Government will complete the Railway Development Strategy for 2020 onwards later this year and will prepare for a study on long-term development and distribution of overall public transportation, having regard to the planning and implementation progress of major transportation infrastructure. This will cover reviews on various public transportation modes including Light Rail with a view to drawing up future public transportation strategy.

Note[1] Reasons accounting for the difference include: (a) platform screen doors and automatic platform gates increase the dwell time of trains at each platform by about 10 seconds; (b) shared tracks on East Rail Line between local train services and cross-boundary services; and (c) train turnaround times for East Rail Line and West Rail Line have lengthened after extension of West Rail Line to Hung Hom Station in 2009.

Note[2] This is because the service frequency has not yet been increased to the maximum level the signalling system permits.

Note[3] For a typical heavy rail train operating in the urban area, there are 340 seats and 2,160 standees under a passenger density level of 6 ppsm, adding up to a total carrying capacity of about 2,500 per train. Under a passenger density level of 4 ppsm, the 340 number of seats will remain unchanged while the number of standees will be reduced to 1,440, adding up to a total carrying capacity of about 1,780 per train. Hence, the carrying capacity under a passenger density level of 4 ppsm is 71.2% of that of 6 ppsm (the respective percentage for Airport Express is 85%).

Note[4] The purpose of providing additional train trips is to maximise the carrying capacity to the maximum carrying capacity when train frequency is maximised and permitted by the existing signalling system (i.e. providing the carrying capacity under item (5) in the table above) in order to achieve the maximum carrying capacity item (2) refers.

Note[5] As Tung Chung Line and Airport Express share tracks at some sections, and that the remaining capacity to maximise the carrying capacity to the maximum carrying capacity when train frequency is maximised and permitted by the existing signalling system of these railway lines would be allocated to Tung Chung Line, hence it is not feasible to provide additional train trips for Airport Express under the existing signalling system.