Dubai Metro

Lakshman Gunatilake MInstCES, ACIArb, PMP, MACostE, MIIE(SL), IEng

Lakshman Gunatilake possesses over 25 years construction experience in the fields of engineering, quantity surveying, contract administration and project management, gained through major international consultancy and contracting establishments in Sri Lanka, the Middle East and Far East Asia

Before travelling himself on the red line of the newly completed Dubai Metro Light Rail Network on 09 September 2009, His Highness Sheikh Mohammad Bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, inaugurated with pride the first urban metro network in the Gulf Arab countries.

By launching as a flagship project in the UAE, the main aim of an overall AED 28 Billion Dubai Metro project is to provide an easy mode of daily travel for the increasing working class of the Emirate. The network is Dubai's version of the London Underground, New York's Subway, Vienna's U-Bahn, Munich's S-Bahn and various other mass-transit systems in other parts of the world. The Dubai Metro is a driverless and fully automated network system and also the longest fully automated railway system in the world. This driverless system is designed to receive power for the railway from a continuous rigid conductor fixed at the side of the track or within the two rails, a system known as the third rail current collection system.

The operation of the Dubai Metro is carried out at present with the hold up of feeder taxi, bus and ferry services provided by the Roads and Transport Authority (RTA) of Dubai that carry passengers to and from the Metro Stations as ancillary services to the Metro network. At present, every station of the network is served by taxies. Stopping bays have been provided to facilitate drop off and picking up of passengers. While encouraging the public to use the Metro as much as they can, with the provision of taxi, bus and water taxi feeder services, the RTA is providing three parks and ride stations having a capacity of about 9,000 car parking spaces. It has been learned that the RTA has considerably increased the number of feeder buses running in connection with the Metro Scheme. The idea is to localize the feeder buses servicing the station around that area so that passengers will not have to walk more than 100 meters from their homes to catch the train. Considering the comfort of metro passengers, in addition to the trains, all servicing foot-bridges, buses and bus stops have now been air conditioned.

The necessity for a transport system of this kind has been identified in Dubai, considering the increasing population of the Emirate due to the growth of the economy, mainly due to increased tourism, property development, air transport and financial services. The traffic congestion in the Emirate has also resulted in authorities looking for an alternative massive transport system of this nature. It is forecasted that the population in Dubai will reach three million people with an annual increase 6.4%.

It was Dubai Municipality that undertook preliminary studies of the project that started in 1997, based on the planning directives given by Dubai's ruler, His Highness Sheikh Mohammed bin Rashid Al Maktoum. Following their study, Dubai Municipality observed that the provision of a rail system would undoubtedly provide some relief to the growing traffic problem. They also expected that the Metro would support continuing urban development in Dubai. Dubai Municipality then awarded the preliminary engineering contract to M/s Systra Parsons and a consortium of four companies, named Dubai Rapid Link Consortium (DURL), headed by Japan's Mitsubishi Heavy Industries (MHI), was asked to build the first two lines of this high-tech driverless rapid transit system. Other consortium members include the Mitsubishi , Obayashi and Kajima corporations and theTurkish Firm Yapi Merkezi. M/s Atkins later undertook the designing of the Works. The overall responsibility of managing the project was then transferred to the Roads and Transport Authority, formed in the year 2005, which is also responsible for other modes of transport services such as the public bus and ferry services. As stated once by the RTA Chairman, "The aims of the Metro are to provide an alternative mode of transport to ease congestion, save

passengers' travelling time and improve mobility within the city…It is intended to provide transport coverage and reach all strategic areas of the city and develop the network to branch out into the suburbs with future extensions." Work on this project officially commenced in March 2006. Since its partial completion and launch in September 2009, it was recorded that Dubai Metro served an average of about 60,000 passengers a day. The responsibility for operation and maintenance of the metro network was given to M/s Serco who possess operation experience with the London Dockland Light Railway network.

System Information:
City Population:
1,492,000 (2006), forecast 5.25 million by 2020
Developer/Operator:
Roads & Transport Authority (RTA)
Date Opened: Red Line - 09/09/2009
Date Planned: Green Line - 10/10/2010
Total Planned System Length: 318km (by 2020)
Gauge: 1,435mm
Lines
Red: 52km (32.3 miles)
Green: 17.6km (10.9 miles)
Design Speed (Max.): 100km/h (62mph)
Stations
Red: 29
Green: 18 (+2 Red Line interchanges)
Operating Hours: 05.00–00.30
Number of Trains required: 87 (Red Line: 62 five-car sets, Green Line 25 three-car sets)
Builder: Kinki Sharyo
Power Supply: 750VDC third rail

Forms of Contract and Method of Measurements
It is stated that the major construction Contracts of the Dubai Metro Project have been procured mainly through the FIDIC 4th Edition, 1982, reprinted in 1992, with amendments. Further amendments have been carried out by the parties to adjust terms and conditions to suit ad-hoc requirements depending on the nature of each construction package. Some of the service provider and supplier Contracts were prepared based on standard international commercial terms and conditions. It has been noticed that the CESMM 3 has been used as the method of measurement for the measuring of construction works, with specific alteration to suit local norms in the civil engineering industry.

Infrastructure of the network

The Red line
The red line is 52.1 km long and runs from Al Rashidiya to Jebel Ali. The red line has 29 Metro Stations out of which 10 stations were ready at the date of opening the network for the public. It takes approximately an hour to travel from one end to the other of the red line and it is estimated that the red line carries about 32,000 passengers within an hour.

The Green Line
The green line is 22.5km long and runs from Al Ittihad Square to the Rashidiya bus station, through Deira City Centre and Dubai Airport Terminals 1 and 3. The green line has 18 Metro Stations. The green line is planned to extend progressively to serve the Deira Dubai and Bur Dubai central areas and souks up to major shopping centres such as New Burjuman and Wafi City. Interchange stations will be at Al Ittihad Square and New Burjuman.

Underground Sections
Red Line - From the intersection of the Sheikh Rashid and Sheikh Khalifa Bin Zayed roads to just before the intersection of the Salahuddin and Abu Bakr Al Siddique roads

Green Line - From the Garhoud to Oud Metha roads
It should be noted that all underground works have been carried out without disturbing residents and without affecting thesurrounding buildings and also the infrastructure provided for the public.

Overhead Sections - Viaduct
Except in the above-referenced underground sections, trains run in the elevated viaducts. A viaduct is a bridge composed of several small spans. The term viaduct is derived from the Latin via for 'road; and ducere, 'to lead something'. In the Dubai Metro, all the tracks ensure full isolation and not a single location of it crosses highways.

Brief about the design and engineering of the Viaduct

Foundation
Most of the spans of viaduct are supported on single span circular RC columns with pier heads to support the deck. Most of these single columns are supported on bored

mono piles of diameter 2200 mm and 2400mm, to aid the speedy construction. That also helped to minimize the footprint required for excavations in the congested areas. These piles and piers have been connected together with a structure like a pile cap.

It was found from tests that the piles needed to be large enough to resist the significant moments generated from out-of-balance forces from the deck, due to horizontal alignment curvature, lateral seismic loading, wind loading, eccentric train loads and other effects.

Substructure
Structural elements included in the substructure of the viaduct are reinforced concrete piers, pier heads and abutments. The pier heads were cast by filling cast in-situ concrete into thin precast concrete shells. The pier heads have pre-stressed in stages after erection at site. However some internal pier heads were casted in-situ. A pile foundation system with a large diameter bored pile has been used.

Superstructure
The superstructure of the viaduct is typically a U-shaped precast RC cross section casted in segments using either long line or short line moulds. Overhead gantries were used to put viaduct sections in place. All standard codes of practice in construction have been observed from inception to completion of the project.

Trains
The trains, with their full system included, were supplied by M/s Kinki Sharyo, with a contract for about 385 cars at the Contract Price of about $456.2 million. When the train is fixed with a set of five cars it is about 75m long. These cars are fully air-conditioned, as designed to meet specific climatic conditions in Dubai. The train has zones; a standard silver class for the general public, a section for women and children only and a first-class 'gold' section that facilitates VIP passengers. The train provides seating for around 400 passengers but with standing room for many more. Numerous double doors will allow fast and smooth flow into trains. The main depot is located at Al Rashidiya and two auxiliary stations are provided at Jebel Ali and Al Qusais. All trains are Wi-Fi enabled.

Payment System and Fares
Train fares are paid by passengers via a smart card identified as a Nol card. Holders of Nol cards can have access to other RTA services such as Buses, Water Buses, as well as pay for RTA's Paid Parking. Passengers should aware that no cash will be accepted to travel in these transport modes. Travelling fares are as announced by RTA and depend on the travel zone and the class, that is, ranging from AED 1.80 to AED 6.50.

Control system

The Operating Control Centre (OCC)
The Operating Control Centre (OCC) is located at the Rashidiya Depot. It occupies approximately some 10,000 m2. It is a fully equipped control room that comprises a driverless train control system and a communications control system for on-train video surveillance, passenger information, public address and the integrated control centre.

Since its launch in September 2009, the Dubai Metro System noted that driverless trains served better without human interaction. According to the RTA, driverless trains have been selected by authorities considering that it is much safer to operate the system with computers, as people may commit mistakes while on duty, for several reasons. The control system used by the Dubai Metro is known as the Seltrac Automatic Train Control System that can operate without human help. However, when trains shutdown due to human error or a system failure, it is required that well trained drivers interfere and bring the system back to normal and cause train to operate.

The overall operation of Dubai Metro is controlled by this high tech equipment set out at OCC and considered to be the head unit of the entire network. The running and monitoring of trains, stations, tracks and tunnels are all responsibilities of the OCC. It has a viewing gallery, maintenance and support room, a room for the police and a crisis management room.

The control system has three levels:
- Normal operation control level, identified as the bronze level
- Operational control level requiring intervention by an RTA emergency response team, where disruption lasts more than an hour, identified as the silver level
- When issues arises at a level that needs top officials from the RTA & the operator Serco to intervene, when operation is halted for more than four hours, identified as the Gold level.

Function of OCC

The OCC has three main functions

- Controlling the movement of trains,
- Monitoring all equipment throughout the network
- Communicating intelligent information.

The railway line was divided into sections that are overseen by operators at the OCC. As trains are run by computers, Metro operation is very simple and safe. Timetables of trains are fed into the computers in the system that has software backup and extra protection. Train schedules are prepared by the OCC team. Schedules includes the frequency of trains and also the distance between trains. Once the schedule is prepared and fed, the system is working on its own with computers. If any changes or adjustment are required, based on continuous analysis by the software system at the Vehicle Control System (VCC), the system does them automatically while communicating with the Vehicle Onboard Controller - a computer installed in every train to ensure smooth operations.

Intelligent system

As it is a self-regulatory system, the VCC gets notified of any emergency via its system and intelligently manages the operations of the train, distance of the train and application of brakes of the train if necessary. Further to the rail system which controls train traffic, the OCC also has an operation control system (OCS) which works subsequent to the rail system and monitors all other secondary systems.

The Operating Control System monitors the ventilation system at tunnels, the fire alarm, public address, communication systems, lighting, air-conditioning and environmental control systems. Though this was designed primarily as a driverless train, it has provisions for manual operation. Manual operation takes place when communication systems fail. The driver/operator always stationed in the train gets message to run the train manually and takes it to the nearest station.

It is noted that about 1,900 people are involved with the metro when it is in operation. The entire operation is observed by 3000 cameras fixed at various locations. A well tested and proven Automatic Train Protection (ATP) system monitors the situation for any breakdown and makes all other trains stop, avoiding crashes between trains. ATP is also linked to heat detection and fire alarm systems. No derailment has happened yet and has very minimal chances of happening in the future. One of the interesting features of this control system is the running of an empty train called the 'sweeping train' on the track every morning to make sure that the track is entirely safe for passengers.

Passenger safety precautions taken

Through the above-described cameras, intelligent communications and information systems, the main Operation Control room monitors all areasof operation of the train network. It plays a major role in evacuating passengers in an emergency. It must take care to manually drive the train to the nearest station. In case the train cannot move, the OCC should send another train to the location for passengers to use. If it is required for passengers to disembark from the train, the OCC will cut off the power supply at the track, 750 Volts DC, for passenger safety. Evacuation points are located every 700m. Passengers may walk up to the nearest point and come down through the staircases.

There may be instances of breakdown of communication between two stations. In such instances, the OCC will mediate and provide buses between two stations for passengers to commute.

Track maintenance vehicles, Platform Screen Doors, derailment containment throughout the Metro main line, continuous fencing and an Intruder Alarm System to prevent people from entering the guide ways are various features which contribute to the safety and reliability of the Dubai Metro. The tracks are protected by concrete barriers and a wayside obstacle detection system.

The future

It is estimated that, when in full operation, the Dubai Metro will carry approximately 1.2 million passengers on an average day and 355 million passengers a year. The budgeted operating cost of AED 570 million a year including costs of staff, maintenance and power is planned to be earned through fares and additional revenues such as advertisement space and joint venture developments and suitable partnering.

As per the plan, the Dubai Metro shall reach all strategic

locations of the city with the development of a branch network into suburbs with necessary extensions. Purple and Blue Lines will be immediate future extensions of the existing network. The Dubai Metro will serve as a means for the improving value of real estate/properties, regeneration in urban areas and economic development of the country as a whole. The Metro will also undoubtedly give a boost to tourism in the country and that will become a starting point to create more employment opportunities.

As understood from studies, the Dubai Metro, when in operation, will reduce traffic congestion by 17 per cent, out of the current total of 30-35 per cent, which can be further reduced by effectively combining the network fully with alternative means of feeder transport which are currently at the planning stage. Some of these include tram feeders, monorail feeders and marine feeders.

It was as early as 1992 when Dubai conducted a feasibility study known as R400, which proposed that Dubai could no longer rely solely on road expansion to cater to its escalating traffic demands. The feasibility study recommended a need for an efficient and cost effective transport system which became a reality through the visionary leaders of Dubai, along with its drive for modernity and environmental concerns, with the birth of the Dubai Metro in the year 2009.

Reference

www.dubaimetro.eu
http://www.railway-technology.com/projects/dubai-metro/
www.gulfnews.com
Wikipedia

Denzil Williams -v- Jean Robertson (Wrongly Described As Robinson) [1999]

The claimant had sought orders alleging a nuisance caused by his neighbour's fir tree. He appealed a refusal of his claim which had been based upon the absence of any evidence to support it.

Because of the long history of complaints between the parties, the court had also made a Grepe -v- Loam Order against the appellant. Held: The appellant had failed to state sufficiently particularly his complaints against the order. The Grepe v Loam order acted as a filter and not as a bar. Appeal refused.