MMRC
ADDING NEW DIMENSIONS

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METRO CUBE

A MUMBAI METRO RAIL CORPORATION NEWSLETTER

Content

MD Speaks

Ms. Ashwini Bhide, IAS

I am confident that Tunneling by TBMs has now attained consistent speed; sections of tunneling are getting completed and delivered for downstream works, as demonstrated by the twin tunnel breakthrough at Dadar by package-4 and two others at CSIAT2 and Sahar by package-6 and package-7 respectively. The contractors have now taken up the new challenge of tunneling by New Austrian Tunneling Method (NATM) for cross passages and stabling lines.

Station works are also geared up to match the progress on the tunnel. More temporary steel decks at stations are getting ready to facilitate remaining excavation works. 15% (cumulative) of base slab works are completed and the works of station walls, concourse slabs and columns have started coming up. More intricate works involving shifting of very old sewer lines in Island city are the unavoidable challenges that the civil contractors are handling with competency.

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Traction Power Supply System

Overhead Catenary System (OCS): OCS is a system of overhead wires used to supply electricity to a train vehicle that is equipped with a pantograph. The three main types of overhead catenary electric traction systems that exist are as follows:

1) Flexible OCS (FOCS)
2) Rigid Overhead Catenary System (ROCS)
3) Retractable OCS

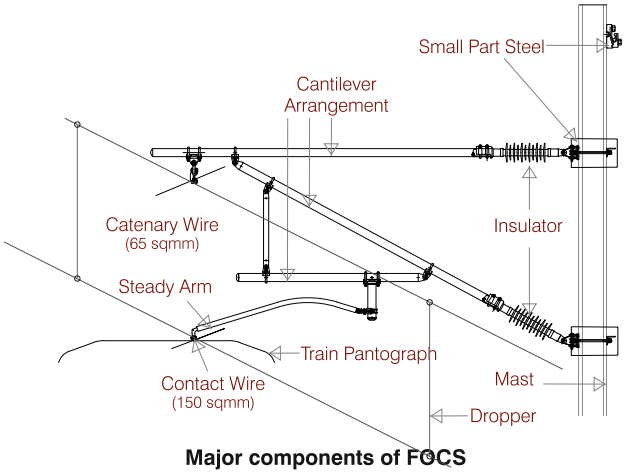
In Metro-3, 25 kV, single phase, 50 Hz AC has been adopted for the traction system.

Flexible OCS

This type of system is mainly used on at-grade and elevated lines where there is no restriction on overhead clearance requirements. It is planned for at grade section including on stabling lines.

Major components of FOCS:

1. Mast
2. Cantilever
3. Small Part Steel (SPS)
4. Steady Arm
5. Catenary Wire (65 mm^2)
6. Contact Wire (150 mm^2)
7. Insulator
8. Dropper

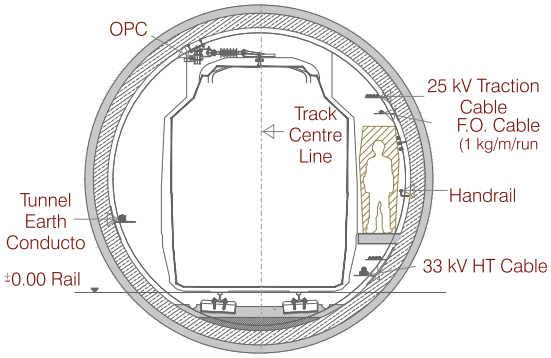


Major components of FOCS

Rigid Overhead Catenary System

This type of system is mainly used in underground lines where there is restriction on clearance requirements due to tunnels. In the underground twin tube tunnels section, the finished tunnel for single track after built tolerances is of typically 5600 mm internal diameter from the design axis of the tunnel. Hence, in order to accommodate the required electrical clearances as per the standard, Rigid OCS has been adopted for traction supply in the underground section.

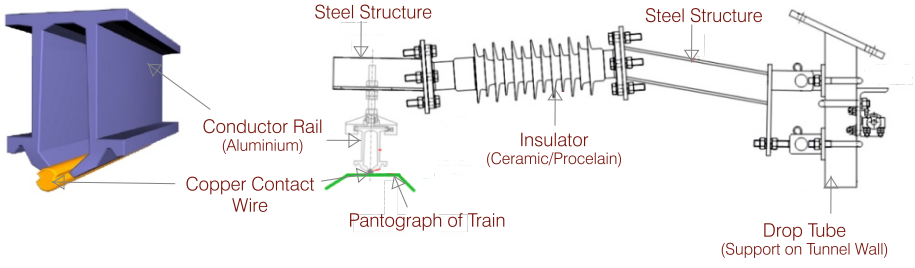
ROCS is simple, robust and flexible as to the required height for installation, which makes them particularly suitable for use in subway infrastructures. ROCS Conductor Rail is formed by an aluminum alloy profile, which accommodates the copper contact wire (with a suitable cross section for the current that allows operative OCS voltages of 25 kV), from where the pantograph on the rolling stock collects power.



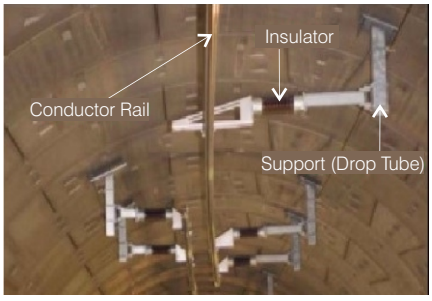
Schematic bore tunnel with ROCS arrangement

Advantages of Rigid Catenary System in comparison with the traditional Flexible Catenary System

i. Less tunnel clearance requirements, less construction cost
ii. More capability of current carrying
iii. No risk of breaking-off, more security
iv. Easy operation and maintenance



Major Components of ROCS



ROCS in Tunnel

1. Conductor Rail

Conductor rail is generally made up of Aluminum alloy by extrusion molding process in 10 m to 12 m long sections. The lower side of the rail has ribs on both sides for the contact wire insertion device which is used for inserting Copper contact wire into conductor rail. The contact wire is clamped with the flanks of the Rail which have a certain flexibility and pincer-shaped bottom ends.

2. Copper Contact Wire (150 Sq.mm)

The Copper Contact Wire is clamped into the conductor rail profile and the conductor rail is supported by steel structures (drop tubes) fitted at specific intervals on tunnel walls.

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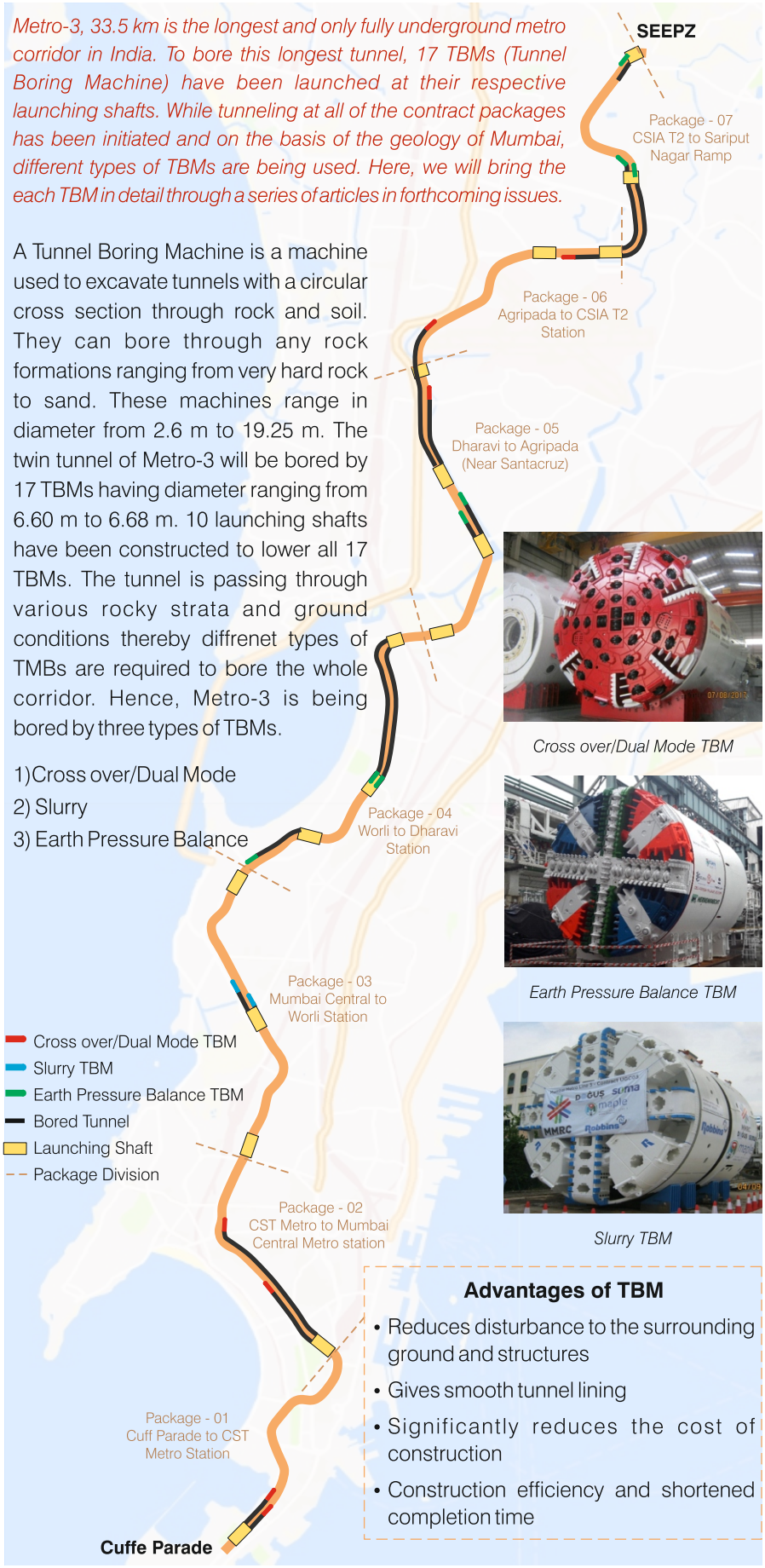
Types of TBM

Metro-3, 33.5 km is the longest and only fully underground metro corridor in India. To bore this longest tunnel, 17 TBMs (Tunnel Boring Machine) have been launched at their respective launching shafts. While tunneling at all of the contract packages has been initiated and on the basis of the geology of Mumbai, different types of TBMs are being used. Here, we will bring the each TBM in detail through a series of articles in forthcoming issues.

A Tunnel Boring Machine is a machine used to excavate tunnels with a circular cross section through rock and soil. They can bore through any rock formations ranging from very hard rock to sand. These machines range in diameter from 2.6 m to 19.25 m. The twin tunnel of Metro-3 will be bored by 17 TBMs having diameter ranging from 6.60 m to 6.68 m. 10 launching shafts have been constructed to lower all 17 TBMs. The tunnel is passing through various rocky strata and ground conditions thereby diffrenet types of TMBs are required to bore the whole corridor. Hence, Metro-3 is being bored by three types of TBMs.

1)Cross over/Dual Mode
2) Slurry
3) Earth Pressure Balance



Cross over/Dual Mode TBM

Earth Pressure Balance TBM

Slurry TBM

Advantages of TBM

- Reduces disturbance to the surrounding ground and structures
- Gives smooth tunnel lining
- Significantly reduces the cost of construction
- Construction efficiency and shortened completion time

MD Speaks

Continued from Page 1

This month was very crucial on Systems work front. The two contracts for installation of heavy-duty Escalators and Elevators for 13 stations; from Aarey to Dadar have been awarded by MMRC. A contract for installation of 176 escalators has been awarded to "Yuanda - Royal Consortium" while installation of 76 Elevators was awarded to CRANEX & IFE JV. The Lifts and Escalators would be of latest technology with VVF type with regenerative, that offer power saving drives and can be maintained through web-based monitoring technology.

The contract for designing and manufacturing of the Tunnel Ventilation and Environment Control System has been awarded to Shanghai Tunneling Engineering Corporation Ltd (STEC) for section1 from Aarey to BKC. As most of the systems contractors are mobilized, our team is geared to finalize the primary design for various contracts including the rolling stock.

Maharashtra Building & other Construction Workers (BoCW) Welfare Board in coordination with MMRC, MAPLE & L&T STEC JV organized a camp at Vidhan Bhavan Station to create safety awareness and distributed safety essentials to the workers.

MMRC team interaction with various stake holders and professional bodies is a continuing activity, where I myself and various senior officers share information on issues and challenges encountered in implementing Metro-3.

The project is now in transition through a crucial stage. The civil contractors have consistently achieved 2.5 km cumulative tunneling for the last 3 months. Similar effort would be required on all fronts for the next 12 months to meet the target completion date. The unresolved permission for tree removal at Aarey needs to be resolve expeditiously. We are hopful that this issue will be addressed on high priority in the coming weeks.

Know Your Station - SEEPZ Station

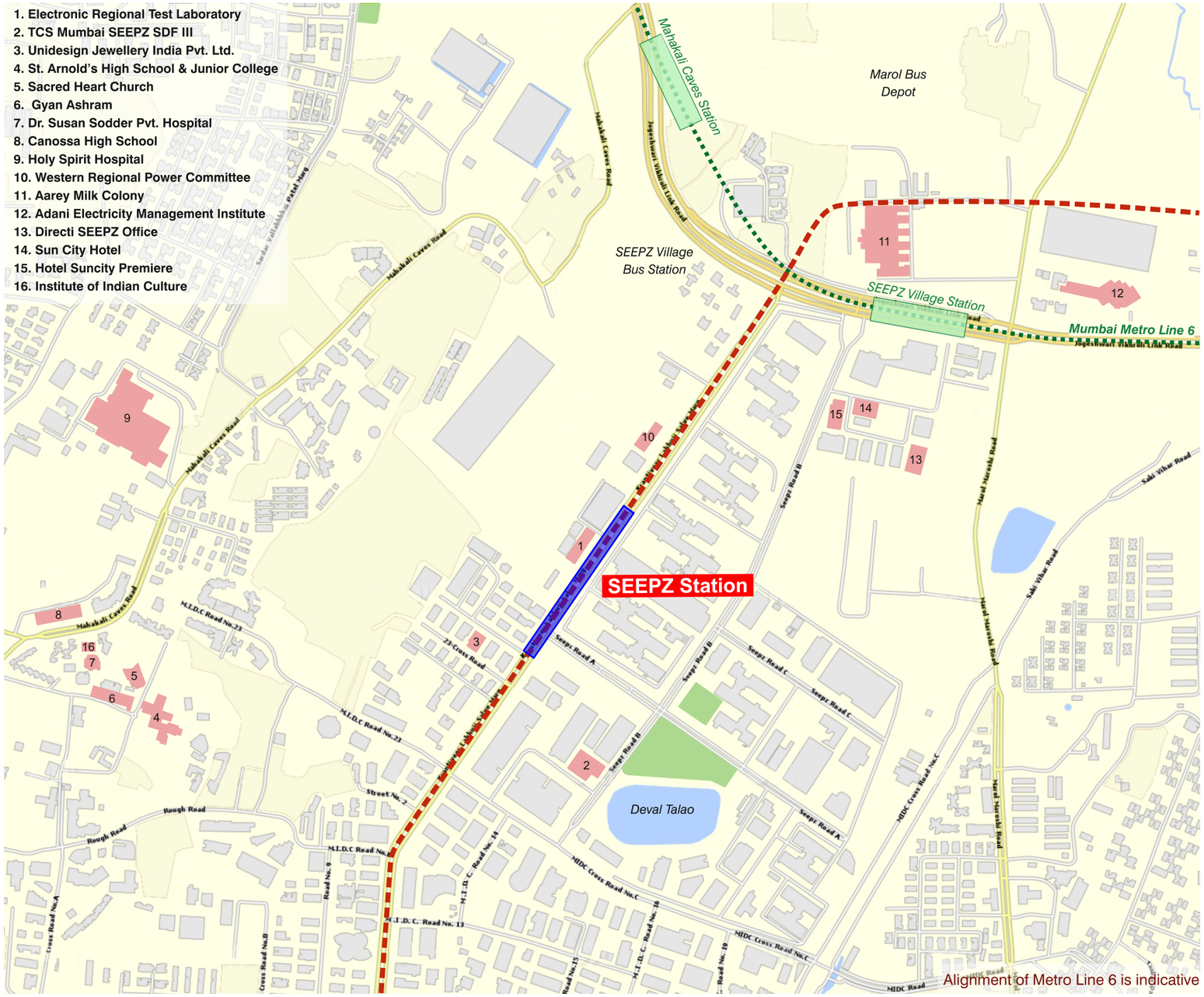
Sacred Heart Church

Holy Spirit Hospital

Electronics Regional Test Laboratory

Institute of Indian Culture

Canossa High School



Map source : http://www.loginmumbai.org/m

Metro-3 will cross the Mumbai Metro Line 6 near SEEPZ. Two stations of line 6, Mahakali Caves and SEEPZ Village are located in SEEPZ area. Now, this area will have the north-south and east-west connectivity as well, which would encourage transforming this locality in different ways. Being a Special Economic Zone, it would attract the developers, exporters, businessmen, traders to set up their businesses, which would add new dimensions to the area around. The proposed Metro-3 Station will serve the important landmarks, such as Electronic Regional Test Laboratory, SEEPZ Village Bus Station, Lodha Eternis, St. Arnold's high School & Junior College, Sacred Heart Church, Holy Spirit Hospital, Hotel Suncity Premiere, Institute of Indian Culture, Aarey Milk Colony, etc.

Santacruz Electronics Export Processing Zone (SEEPZ) is a Special Economic Zone, situated in Andheri East. It was established in 1973 and mainly houses electronic hardware manufacturing companies, software companies and jewellery exporters of India. To promote the rapid economic growth, the area is subjected to liberal economic laws as compared to other areas. So far, SEEPZ is being mainly served by BEST buses and Mumbai Metro Line 1. Nearest stations on Metro Line 1 are; WEH, Chakala and Airport Road, which are 2 to 2.6 km from proposed SEEPZ station. The nearest station on Western Railway is Andheri, which is around at a distance of 3.7 km. But still, this area is far off from direct reach of Central Railway.

SEEPZ Station is the 26th and last underground station from Colaba, will be followed by Aarey Station which is at grade and the end station on Metro-3 corridor located at Aarey Depot. Proposed SEEPZ station is located underneath the MIDC Central Road. This additional connectivity would boost the development of the area as it will be directly connected to the South Mumbai. The travel time from Colaba to SEEPZ would reduce by 35% through Metro-3.

SEEPZ Station work is in progress

Waterproof Metro-3

Metro-3 is a 33.5 km fully underground line comprising of 26 underground stations and 1 at grade station. Metro-3 is constructing tunnels with the help of Tunnel Boring Machine (TBM) and New Austrian Tunnelling Method (NATM). Stations are being consructed by Cut & Cover and NATM method. About 53.79 km tunnel will be constructed by TBM and 706 m by NATM. Seven stations are fully or partially constructed by NATM and remaining 19 stations are constructed by Cut and Cover method. The tunnels and underground stations are permanently in contact with surrounding ground as well as below ground water table. In this scenario, to achieve the durability of structures, waterproofing is necessary for the structure to serve its design life expectancy.

What is waterproofing?

Waterproofing is a process of making an object or structure water-resistant so that it resists the ingress of water under specified conditions and remains relatively unaffected by water. It is a technique used in the construction and design industries through the application of elastic and durable membranes to curb the effect of penetration of environmental liquid into the system.

Need of waterproofing

Water infiltration causes major problems to a structure. Water starts to damage a building first cosmetically and then structurally. Tunnels are built with a design life expectancy of over 100 years, which means that standards for tunnel construction must be high, particularly those involving sealing and waterproofing systems. Waterproofing protects the tunnel against damage from moisture or unintentional entry of water, danger posed by aggressive water or soils and effects of chemicals. Water along with dissolved salts from the soils will try to penetrate the tunnel lining thus deteriorating the lining which would adversely affect the durability of tunnel lining. Water entering the concrete will start corroding the reinforcement/steel causing it to expand in size resulting in spalling of concrete. Thus, reliable functioning of waterproofing system is of particular significance in the case of traffic tunnels, like railways, which are not accessible or stopped for subsequent repairs after seepages or leakages.

Waterproofing Methods

The protection of an underground structure can be performed using a positive side (exterior) or negative (interior) waterproofing system. In general, the preferred system is a positive side waterproofing system that protects the structure from all types of attack while providing a tight waterproof membrane. Negative systems are typically used in rehabilitation systems where the exterior of the structure is not accessible. In order to understand the applications of waterproofing it is necessary to have knowledge of the principles of waterproofing below ground structures. It is important to understand the difference between waterproofing which is a coating or membrane that prevents the free passage of all water through a medium, while water-resistant prevents the limited passage of water vapour or water through a medium by the use of a membrane, coating or physical properties. There are numerous waterproofing systems available in the market place:

- Liquid systems toweled or mopped
- Panel systems
- Sheet membranes
- Epoxy systems
- Sprayed systems

In Metro-3, different waterproofing methods have been adopted for tunnel and station box. Adopted techniques will be discussed in detail in forthcoming issues.

Traction Power Supply System

Continued from Page 2

3. Support

Adjustable supporting fitting for conductor rail so as to maintain the geometry of height and stagger of contact wire with respect to the track alignment.

4. Insulator (Ceramic/Porcelain)

It is mounted at the top part of the profile, working as its support. It is provided with sliding steel structure, which allow free longitudinal movement of the conductor rail, without any additional stress for the insulator.

Retractable OCS

Mainly used in inspection lines of depots, where release of space is needed above the train to make all the necessary major maintenance activities with the use of gantry/EoT crane etc. Retractable OCS permits to freely let in and get out trains and locomotives in metro maintenance depots and workshops without any interruption and additional hauling systems. Rigid OCS (of 10 to 12 meter length) is hung to several motorized swiveling jib arms. The union of rigid catenary and jib arms is named 'Retractable Rigid Catenary'.

(a) Normal Position
(To freely "let in" and "get out" of a Train)

(b) Retracted Position
(For overhead maintenance of a Train)

Expert Speaks

Find Your Way to Metro

Our author for 'Expert Speaks' section for this month is Mr. Yoshiya Nakagawa, from Japan. Mr. Yoshiya has worldwide experience in transportation planning and engineering and was involved in initial multimodal integration studies for Metro-3. He has been a Secretary of Journal Editing Committee of Japan Society of Civil Engineers and has been associated with master's program of Graduate School of Nagoya University.

The transit-oriented development (TOD) has already been known to planners and engineers, and early adopters in Mumbai as a keyword for further promotion of mass-transit services. This approach however covers engineering and physical infrastructure development, and there is little understanding of how TOD can be promoted in actual market. This is very evident in the way addresses of major landmark destinations in different cities are presented. For this, we can look at a series of examples from Japan and other countries, though those seem strange in the beginning.

To start with, let us compare different ways in which addresses of important landmark locations are displayed on different media in different target cities in the World. The target cities are Mumbai, New York City, Paris and Tokyo. We checked websites of 12 locations (offices, retails/shops, social/medical, culture/entertainment) randomly in the target cities, and checked how they present the online way of access to these destinations. Following table can summarize the results.

Directional Information Presentation in the Target 4 Cities

	No. of Destination	Google map	Transit info	Parking info	Bicycle info
Mumbai	12	42%	8%	0%	0%
NYC	12	83%	25%	17%	0%
Paris	12	75%	58%	50%	33%
Tokyo	12	83%	100%	42%	0%

Information summarized about Tokyo is unique from all cities. All websites of destinations in Tokyo on their address show which is the nearest metro line and station for best accessibility. Some sites also show which exit of Metro Station or which bus lines can be used for the nearest access, time required for riding and walking to the destination. Paris has relatively high presence of transit info, and also show rental bicycle stations (the velib system).

New York City does not have much transit info but some sites show information about wheelchair accessibility commonly. Mumbai has least information on the relationship of their properties with mass transit services, as compared to other cities. This small exercise shows how transit services are rooted in those cities.

This is the true spirit of ingraining TOD in city planning and popularizing metro transit as a preferred mode of commute. There is no law or no regulation, but people and companies in Japan voluntarily present their directional information by transit services and share how their locations are incorporated into the transit systems physically with their customers and visitors. Such directional presentation is commonly shown in street advertisement and yellow pages. Similar integration of Metro routes, closest station, exit, walking minutes and transit services for passenger access can be shown on the address of important landmark destinations to promote choice of Metro. Some may say that use of smartphones, google maps etc can help overcome such gaps. However, this unique attempt to integrate transit information can inculcate the awareness about public transport in minds of people.

Breakthroughs

This month MMRC witnessed the 5th and 6th breakthrough of Metro-3 corridor at CSIA (International) Station and Sahar Road Station respectively.

Wainganga 3 TBM, which was commissioned on 2nd April 2018 from Pali Ground completed its tunnel drive of 1.31 km in package 7 to see the light at its end at CSIA (International) Station.

Tapi 1 TBM was commissioned on 13th September 2018 form CSIA (international) Station completed its tunnel drive of 692 m in package 6 to see the light at its end at Sahar Road Station.

News @ MMRC

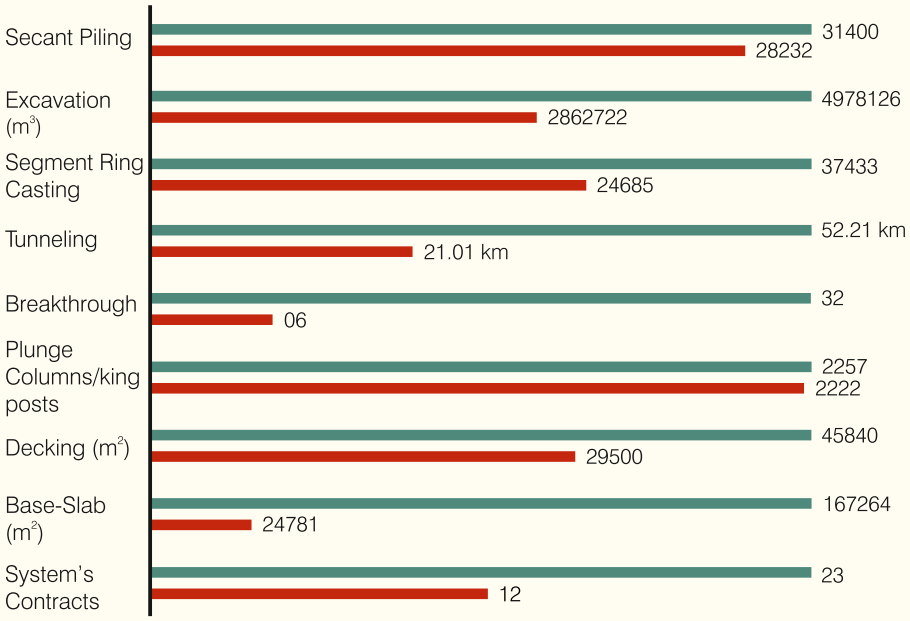
Tunneling by New Austrian Tunneling Method (NATM) commenced at the south end of BKC Station for the 153 m long tunnel below Mithi River. This will facilitate stabling of spare train during operations. This will also act as a Sick Siding.

Mr. Kenichi Ide, first secretary, Embassy of Japan along with Noriaki Ebii, Dir. Padeco visited BKC metro station site, where they were updated in detail about the ongoing progress of the project.

MMRC will be planting and maintaining fully grown trees at Metro-3 sites (open spaces) as a part of restoration. ED Planning, Mr. R. Ramana visited the selected contractor's (Pkg.19) nursery at village Kashti, Ahmed Nagar.

Project Progress Update

As on 23rd February, 2019



An elaborate steel deck installed at Vidhan Bhavan metro station so that traffic can move swiftly along with taking place underground Metro-3 work.

Legend
Planned
Completed

Mumbai Metro Rail Corporation
NaMTTRI Building, Plot No. R-13
'E'- Block, Bandra Kurla Complex,
Bandra (E), Mumbai 400051.

Website Link

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