



# METRO MOVES!

**CW** explores upcoming opportunities, trends, challenges and solutions in the metro sector.



## QUICK

- India's introduction of metro will support metro and sustainable and sustainable
- The presence of skilled labor opportunities more universal
- Global are of aesthetic quality green



## QUICK BYTES

- India's target of introducing 70-100 km of metro lines per year will sustain rail designers, metro contractors and suppliers and sub-suppliers.
- The present shortage of skilled personnel is an opportunity to introduce more rail-based syllabi in university curriculums.
- Globally, metro designs are aiming to combine aesthetics, technical quality and green attributes.

Plenty of new and expansion projects are on the anvil in India's metro-rail sector. We list a few proposed big-ticket expansions:

rail systems are either being implemented or are in the planning process," points out SV Desai, Whole Time Director and Senior

Project	Network	Corridors	Project Cost
Ahmedabad Metro II	61.79 km	2	₹16,157 crore
Dholera Metro	100.0 km	2	₹7,000 crore
Delhi Metrolite	40.85 km	2	₹5,587 crore
Mumbai Metro	87.6 km	3	₹33,104 crore
Meerut Metro	20.0 km	1	₹11,544 crore
Nagpur Metro II	48.3 km	1	₹11,216 crore
Nagpur Broad Gauge Metro	268.63 km	4	₹418 crore
Surat Metro	40.35 km	2	₹10,829 crore
Thane Metro	29.0 km	1	₹13,095 crore

Plans to introduce 70-100 km of metro lines per year over the next decade or so are likely to sustain rail designers, metro contractors and suppliers and sub-suppliers of metro systems, observes

**Harsh Dhingra, Management Consultant, Rail and Metro.**

"Opportunities will also arise for private players to lease systems and subsystems and train operations and this will improve overall efficiency. The prevailing shortage of technically qualified and trained personnel (see box on challenges) is an opportunity to introduce more rail-based syllabi in technical universities and ITIs as well as private institutes to train more people."

### Contractor speak

What do contractors and consultants say about the upcoming opportunities?

"With metro-rail systems already established in the major metro and Tier-I cities, the focus has shifted to Tier-II cities like Bhopal (7 km), Indore (17.5 km), Patna (31 km), and Vizag (80 km), where metro-

Executive Vice President (Civil Infrastructure), L&T. "We are actively considering these opportunities that will give us the opportunity to explore new



**"L&T is developing suppliers for critical items to debottle-neck the supply chain and be self-reliant."**

- **SV Desai**, Whole Time Director & Senior Executive Vice President (Civil Infrastructure), L&T



**"Standardisation is associated with significant design reuse, up to 85 per cent notwithstanding inflation."**

- **Harsh Dhingra**, Management Consultant, Rail and Metro



Photo courtesy: Consulting Engineers Group



## COVER STORY

## Metro Technologies: Trending Towards Standardisation

Harsh Dhingra, Management Consultant, Rail and Metro, has seen a shift towards the standardisation of metro design in the past few years.

Conceptually, the train design is now trending towards a three-coach/six-coach option for 25 kv catenary power supply (as in Delhi/Mumbai) and a three-coach option for third rail 750 v (Kolkata/Ahmedabad/Bengaluru) from the previous three, four, six and eight-car options, says Dhingra.

To put this evolution in perspective, Surjit S Madan, Director (Planning), Personal Rapid Transit System, Atriya Abundense, says, "Standardising the rolling stock to a three-car design expandable to a six-car design would meet a peak passenger requirement initially of about 20,000 passenger per hour per direction traffic (PHPDT) with 180 seconds headway and eight passengers per sq m standing occupancy, and then double this, for an overall capacity of 800,000 passengers in both directions per day, for a nearly 20-km-long system."

"The use of communication-based train control (CBTC) with automatic train protection (ATP) and automatic train operation (ATO) for signalling, is now becoming a standard feature in all metros," adds Dhingra. "With this, the operator will be able to run trains with a one-minute frequency as against the three

to six-minute frequency norm for peak periods with conventional signalling."

With CBTC signalling, a six-car train would have a passenger capacity of 60,000 PHPDT with a 120-second headway, thus catering to 1.2 million passengers in both directions, sufficient capacity for a city inhabited by over 5 million people, points out Madan. "With CBTC signalling and driverless operations, shorter trains can be adopted in metro cities or the headways can be further reduced to 90 seconds or lower to increase passenger capacity."

Adopting a standard gauge (1,435 mm) track on most metros as opposed to Delhi Metro's early broad gauge (1,676 mm) track aligns Indian metros with most metros globally, continues Madan. "Shifting from the 25 kVAC traction power supply adopted in the Delhi Metro to 750 V DC traction to reduce the rolling stock's axle load by 1 tonne for better energy-efficiency and lower maintenance cost has also reduced the civil construction cost for elevated metros."

"Standardisation is associated with a significant design reuse, up to 85 per cent notwithstanding inflation, which, in turn, reduces or stabilises the cost of the train and the signalling system, elements accounting for around 30 per cent of the cost of the metro," explains Dhingra.



**"The private sector does not find the PPP model for transit projects attractive."**

- Dr GVR Raju, Senior Vice President, Global Transportation, Europe & India, AECOM

cities and create employment opportunities for the local population."

"We are actively pursuing underground metro opportunities in India and Bangladesh," says Raman Kapil, Executive Vice President & BU Head - Metros,



**"Metro rail projects worth ₹2 trillion are at the approval stage."**

- Vishwas Jain, Managing Director, Consulting Engineers Group

Tunnels & Environment, Tata Projects. "We are focusing on underground opportunities mainly for our own expertise and because most of these projects are funded by multilateral agencies. We successfully completed the Lucknow Metro in 2017 and are

currently executing the Pune and Chennai underground metros."

"We are looking to get involved with metro projects in Ahmedabad, Jaipur, Kanpur, Patna and Varanasi," says Rambabu Sabbineni, Vice President, P&M, JMC Projects (India). "These may be both overground as well as underground metro construction projects."

"With metro rail projects worth ₹2 trillion at the approval stage, we are looking forward to new metro, light-rail metro and Metro Neo projects on similar lines as the present general consultancy, proof checking and detailed design consultancy projects we have in hand for metros in over eight cities," says Vishwas Jain, Managing



VISIT  
BOOT

baun  
CONE

31 Jan. -  
India Expo Centre,



## COVER STORY



Photo courtesy: AECOM

Once the PPP model aligns with the expectations of the stakeholders, private equity will become popular to establish metro systems.

Director, Consulting Engineers Group. "Our work includes design, proof checking, project management and general consultancy for civil, systems and operations and maintenance (O&M), for elevated and underground sections, including depots."

#### Futuristic developments

While a variety of opportunities will arise, with greater awareness of the lifecycle cost and the better financial leverage arising from a long-term business association, Dhingra foresees a shift from mere procurement to procurement-cum-maintenance ordering for major systems like coaches, signalling and telecom equipment, lifts, escalators, and depot equipment.

The private sector does not find the PPP model for transit projects attractive owing to the high capex, high cost of borrowing and controls on passenger tariff, opines Dr GVR Raju, Senior Vice President, Global Transportation, Europe &



**"We call experts from overseas to advise us on soil and geological issues because they have more experience in facing such issues."**

- Rambabu Sabbineni, Vice President, P&M, JMC Projects (India)



**"At the global level, metro station design is striving to combine aesthetics, technical quality and high green ambitions."**

- Mohammad Wamiq, Sr Architect (Infrastructure), GPM Architects & Planners

India, AECOM. To tide over this funding challenge, Dhingra expects the PPP model to align with the expectations of all stakeholders; this will see private equity being used to establish metro systems.

Speaking of the key drivers of public transit in future, Dr Raju lists the hybrid working culture, Gen Z's penchant for shared services and the growth of satellite townships around major cities. He expects connected autonomous vehicles (CAVs) to provide seamless connectivity between residential, commercial and recreational areas.

Coming to the influx of new technologies, with hydrogen fuelled trains being tested, Sunil Srivastava, Managing Director, Balaji Railroad Systems, believes it is possible that "not too far in the future, we may also see urban transit systems running on hydrogen or solar power."

Mohammad Wamiq, Senior Architect (Infrastructure), GPM Architects & Planners, sees





## COVER STORY

## Global Trends in Station Design

At the global level, metro station design is striving to combine aesthetics, technical quality and high green ambitions, says Mohammad Wamiq, Sr Architect (Infrastructure), GPM Architects & Planners. "Implementing the latest and advanced materials helps to come up with an aesthetic design of a high quality."

Considering that having a metro system is on some level a status symbol for a state/city, reflecting the local environment also sometimes becomes a design priority, for which architects look to local culture and heritage and major landmarks that the metro route passes through, he adds. "For example, the interiors of stations in Chengdu, China, are based on forms and patterns found in nature and influenced by the local tradition of silk-weaving as well as the flora and fauna found in surrounding parks. In India, the Pune Metropolitan Region Development Authority is following the example of the Maha-Metro in designing metro stations that reflect the local culture."

the scope for transit-oriented development to add value to India's metro-enabled cities. Transit-oriented development in urban spaces maximises the amount of residential, commercial and leisure

space within walking distance of public transport. In Hong Kong, for instance, he points out that approximately 41 per cent of the population lives within 500 m of a metro station.



**"With CBTC signalling, a 6-car train would cater to 1,200,000 passengers, sufficient**

**capacity for more than 5 million people."**

- Surjit S Madan, Director (Planning), Personal Rapid Transit System, Atriya Abundense



**"Not too far in the future, we may also see urban transit systems running on**

**hydrogen or solar power."**

- Sunil Srivastava, Managing Director, Balaji Railroad Systems



Transit-oriented development has the scope to add value to India's metro-enabled cities.

Photo courtesy: GPM Architects & Planners



## COVER STORY

## Will the Metrolite see the light of day?

Most cities that have introduced conventional metro systems have been unable to utilise the full capacity of the system, observes **Sunil Srivastava, Managing Director, Balaji Railroad Systems.**

So now that the Government is recommending the use of rail-based urban transport systems in cities with a population of 3 million and above, subject to commercial viability, what route should those cities follow?

"If Tier-II and Tier-III cities with a population of less than 5 million in the next 30 years adopt the standard rolling stock configuration, they will end up with oversized metros to begin with that continue to be unsustainable due to a higher capital cost and a higher operating cost throughout their lifespan," observes **Surjit S Madan, Director (Planning), Personal Rapid Transit System, Atriya Abundense.**

Consequently, "in terms of the overall metro design, the Metrolite and Metro Neo are two technologies that are seriously being considered for implementation in various Tier-II cities over the conventional heavy metro due to their lower capital as well as operating costs," says Srivastava.

The single-vehicle Metrolite is a modern tram system without exclusive RoW, with a 300-passenger capacity for a 33-m-long single articulated vehicle of three to five cars, and a 180-second headway at best because of mixing with road traffic at junctions, explains Madan.

Metrolites or light rail transit (LRT) systems have been successfully running for several years in various parts of the world, points out Srivastava. "And these systems as also light metro cars, automatic people movers, and monorail systems, can impact the cost of constructing a metro system upto 20 per cent," adds **Harsh Dhingra, Management Consultant, Rail and Metro.**

Also, LRT systems are the future for clean and efficient public transport, says Srivastava, who believes that the Metrolite could also be considered for future expansion in cities with existing metros, albeit with appropriate interchange arrangements.

Having seen larger cities implement metro rail systems with a 20,000-50,000 PHPDT capacity, costing from ₹250 crore/route km for elevated



Photo courtesy: Balaji Railroad Systems

Metrolite and Metro Neo are popularly considered for Tier-II cities owing to their low capital and low operational costs.

sections to over ₹500 crore/route km for underground sections, some cities are now considering alternatives such as the Metro Neo and Metrolite with a capacity of 5,000 to 25,000 PHPDT, costing anywhere between ₹30 crore/km to ₹170 crore/km, observes **Dr GVR Raju, Senior Vice President, Global Transportation, Europe & India, AECOM.** "Cities are looking for the right solution for their current and future needs vis-à-vis the capex involved. The key challenge is the selection of the right single or mix of systems with sustainability and decarbonisation in mind. The cost and viability for last-mile connectivity is still a challenge in many cities with a sufficiently advanced metro network."

The disadvantage of the Metrolite is its low capacity. A 33-m-long vehicle offers a 6,000 PHPDT while a 45-m-long vehicle offers 8,500 PHPDT. Even if two vehicles were coupled, the capacity would be way below the three-car and six-car train 30,000 to 60,000 PHPDT capacity, respectively, says Madan.

To bridge this gap and offer a sustainable solution that cuts the capex and opex by 25 per cent, the Andhra Pradesh Metro Rail Corporation has developed a specification for a driverless light metro, continues Madan. "Rolling stock would have a lower axle load of 12 tonne against the present 15/16 tonne with DC/AC traction, respectively. Its configuration would be two-car to start with, expandable to three-car or four-car (even five or six car), with the four-car achieving a 24,000 PHPDT capacity with a 120-second headway and six persons per sq m."

For a  
geared  
a

www.jsws  
Toll-free N



## COVER STORY

## Construction and Design Challenges

What are the main challenges associated with the construction of metros and the design of metro stations across Indian cities, and how can these be surmounted?

**Raman Kapil, Executive Vice President & BU Head - Metros, Tunnels & Environment, Tata Projects**

- **Key challenges:** The safety of stakeholders, the presence of excessive utilities along the right of way, traffic management and the movement of heavy equipment.
- **Solutions:** At Tata Projects, well-planned actions are implemented to ensure a safe and progressive work environment at all job sites. A robust safety system along with a focused group to handle utilities and traffic diversions and in-depth logistic plans are crucial requirements of any metro projects.

**SV Desai, Whole-Time Director & Senior Executive Vice President (Civil Infrastructure), L&T**

- **Key challenges:** The shortage of workmen and staff with the right skill sets to handle large volume/scale projects. The dearth of qualified engineers. Supply chain constraints to meet the increased volume of business is another challenge as well as a deterrent to growth. The supply chain is constantly having to play catch-up.
- **Solutions:** We are addressing the issue of scarcity by drawing trained workmen for various trades from our Construction Skills Training Institutes that have been established across the country. To bridge the qualified engineers' gap, L&T has taken, and is in the process of taking, several strategic hiring measures to tap the right kind of talent. To surmount the supply chain problem, under the Atmanirbhar Bharat initiative, L&T is developing suppliers for critical items to debottleneck the supply chain and be self-reliant. Many of these suppliers are MSMEs with the potential to scale up their activities over time.

**Surjit S Madan, Director (Planning), Personal Rapid Transit System, Atriya Abundense**

- **Key challenge:** Optimising the system design to reduce construction time and cost.
- **Solution:** Ideally, metro authorities should select a rail system for acity based on traffic studies rather than have a ministry standardise an overall system.

**Mohammad Wamiq, Senior Architect (Infrastructure), GPM Architects & Planners**

- **Key challenges:** Metro-station design faces challenges on account of space availability, land acquisition, meeting the passengers' demands and maintaining the standard level of service for a huge passenger flow. From the cityscape design, the biggest challenge is that the city skyline gets buckled because of the widespread concrete viaduct network.
- **Solutions:** Optimising the service and utility rooms helps reduce the size of underground stations and thus reduce the cost of construction. Taking the metro underground would help preserve the skyline and enable more futuristic development. However, current development trends suggest that integrating a metro's above-ground and underground space paves the way for future developments.

**Rambabu Sabbineni, Vice President, P&M, JMC Projects (India)**

- **Key challenges:** Unknowns surrounding the soil kind and geology. While some study of these aspects is done at the project conceptualisation and design stage, a full study is practically impossible. Tunnel-boring machines (TBMs) must be imported, which causes delivery delays on top of which the logistics costs have increased manifold after the pandemic.
- **Solutions:** We call experts from overseas to advise us on soil/geological issues because they have more experience in facing such issues. TBM delays will continue until the machines are made in India.

**Dr GVR Raju, Senior Vice President, Global Transportation, Europe & India, AECOM**

- **Key challenges:** Shortage of skilled labour on the back of the global surge in infrastructure spending post-COVID, owing to which a lot of work is being outsourced to design/capability centres in India, pushing up salaries and enhancing attrition. Indian youth prefer the service sector to the construction sector. Construction is seen as a tough industry with moderate growth prospects.
- **Solutions:** Contractors must invest in modern equipment and systems to reduce their manpower requirement. Targeted programmes and training would help cultivate the required skilled people. Investments and incentivisation to promote the use of



## COVER STORY

digital tools, precasting and standardised solutions for the transit industry.

### Vishwas Jain, Managing Director, Consulting Engineers Group

- **Key challenges:** Metro projects are capital-intensive (about 60 per cent of the total cost is on account of civil work) and subsequently run into losses at the O&M stage owing to subsidised fares.
- **Solutions:** Conduct extensive due diligence at the conceptual design and planning stage. Emphasise public transport, multimodal integration, and smart city. Government efforts to standardise metro components and Make in India have helped reduce the capital cost as well as the O&M cost from the

design stage itself for civil, rolling stock, CBTC signalling and telecom, platform screen doors, automatic fare collection, electrical and mechanical. Effort and value addition at the design stage can reduce the size of stations. Cost reduction for the viaduct and station designs can help optimise the length of piles after detailed geotechnical investigations and permit the extensive use of cost-effective precast elements (U-girders, I-girders, and station elements) for better quality control and faster completion. Energy-efficient designs and components help reduce electricity bills, which constitute 50-60 per cent of the operational cost. Introducing driverless rolling stock as well as outsourcing O&M helps cut costs. More such cost-effective solutions to be explored.

The Metro Rail Policy 2017 mandates transit-oriented development for metro projects, which will be challenging to implement in Indian cities. Wamiq continues, "But taking the example of Ahmedabad's new city master plan, smaller steps towards this aim can be taken and opportunities will arise. We look forward to delivering our services for transit-oriented developments to further India's



**"We are actively pursuing underground metro opportunities in India and Bangladesh."**

**- Raman Kapil, Executive Vice President & BU Head - Metros, Tunnels & Environment, Tata Projects**

socioeconomic development."

With the world seeing a prominent shift from stations to multimodal transport hubs, Wamiq also sees the design needs of stations changing in future.

### Justified expansions

For the most part, Srivastava believes that the planned expansion of metro lines in India is justified in most cases. In some cases, the corridors have been extended to meet the growth, whereas in other places growth has followed the new corridors.

"Global experience shows that most metro systems are in a continuous expansion mode mainly because cities don't stop expanding and, as a consequence, there is always a need for a good public transit system to meet the growing needs of the citizens," says Srivastava. "Any metro system cannot be a one-off activity; planned expansion is a must to keep pace with the growth of the city. In fact, I would say that if a metro system is not being expanded, the city didn't need a metro system in the first place."

**- CHARU BAHRI**



A robust safety system, a focused group to handle utilities and traffic diversions, and in-depth logistic plans are crucial requirements for any metro project.

How do you think India's metro rail landscape is progressing? Write to us at [Feedback@ConstructionWorld.in](mailto:Feedback@ConstructionWorld.in)