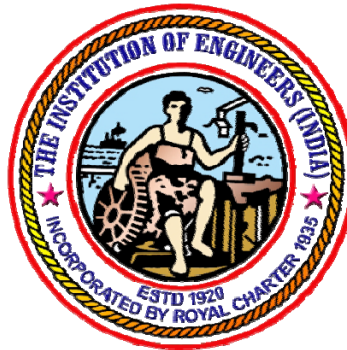


The Institution of Engineers (India)

Andhra Pradesh State Centre



Dr.A.Ramakrishna 2nd Endowment Lecture

on

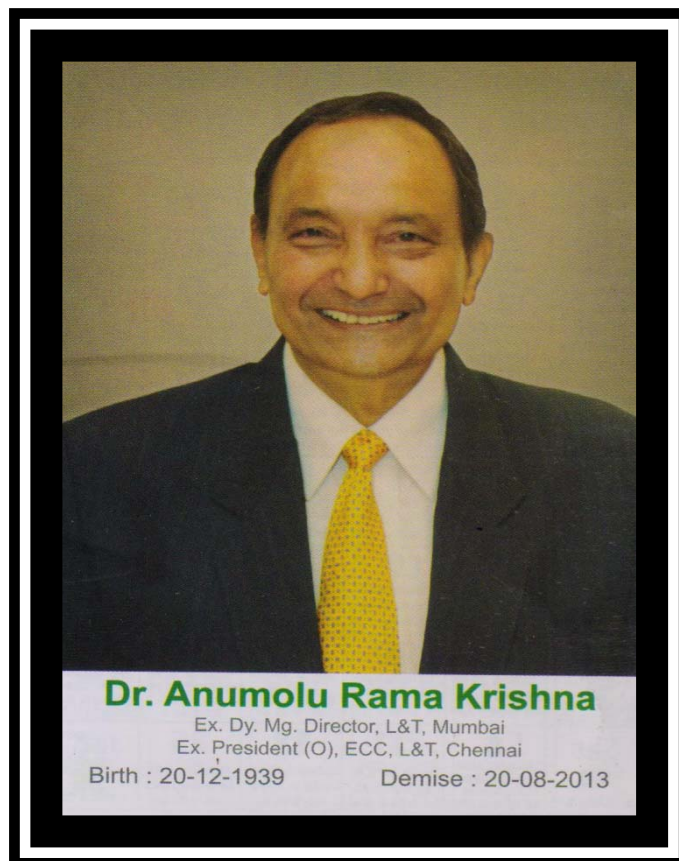
HYDERABAD METRO RAIL AS AN ENGINEERING INNOVATION AND URBAN REDESIGN OPPORTUNITY

by

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Dr. Anumolu Ramakrishna was born on December 20, 1939 at Punadipadu, Andhra Pradesh. He obtained his bachelor's degree in Civil Engineering in 1960 from the Andhra University and M.Sc in Structural Engineering in 1961 from the College of Engineering, Gundy, Chennai. He started his career in 1962 with Engineering Construction Corporation Limited (ECC), the then a wholly owned subsidiary of Larsen & Toubro Limited. The ECC was subsequently amalgamated with the parent company and is widely known as ECC Construction Division of Larsen & Toubro.

In 1966, Government of India sponsored him for practical training in Structural Engineering in Germany. His specialized knowledge in structural engineering - precast and prestressed concrete and industrialized methods of construction which has been recognized through scores of projects for which he contributed design and construction services. His specialized knowledge in structural engineering precast and prestressed concrete and industrialized methods of construction was recognized by Andhra University duly conferring upon him Honorary Degree of Doctorate of Science in 1997 and by Jawaharlal Nehru Technological University through an Honorary Degree of Doctor of Philosophy in 2004.

After serving in various capacities Dr Ramakrishna was inducted into the Board of Directors of L & T in 1992 and was appointed as President (Operational head) of the ECC Construction Division. He provided the leadership for the construction of scores of cement plants, steel plants, power

projects, refineries and petrochemical complexes besides outstanding buildings, roads, bridges, harbours, airports, water supply projects, and nuclear power plants. He was elevated to the position of Deputy Managing Director of L&T in March, 2000. Under his leadership the revenues of L&T – ECC Division grew manifold – from Rs. 450 Cr. in 1992 to over Rs. 6,900 Cr. in 2004 by the time when he retired from the services of the L & T Company.

Dr Ramakrishna was actively associated with many prestigious International and National bodies of the Engineering field. Dr Ramakrishna initiated expansion of L&T ECC into overseas markets especially in neighbouring countries, responsible in securing large orders and earning foreign exchange. This has helped speedy access to advanced technologies and construction methods for wider application in India.

Dr Ramakrishna introduced new segment in L&T, ECC's business portfolio and was instrumental in developing Roads, Bridges, Seaports and Airports in addition to IT Parks. He played a pioneering role in development of projects under the Public Private Partnership format and most of these projects have become landmarks exemplifying quality, speed and economy.

Dr Ramakrishna has received many prestigious awards for his outstanding contribution to engineering technology and to the society at large. Dr Ramakrishna was inspired by the vision of

Dr A P J Abdul Kalam to make India a developed nation by 2020.

Dr A Ramakrishna, FIE, was recipient of WFEO Award “2007 HASSIB SABBAGH AWARD FOR ENGINEERING CONSTRUCTION EXCELLENCE” on 15th November, 2007 in New Delhi and he donated the prize money of US\$10,000 to IEI, A P State Centre, Hyderabad.

Many, both in India and abroad see Dr A Ramakrishna as an exemplary Engineer and Leader who combined technical excellence with honesty, integrity and human values in business. He showed the way to transform construction scenario in India and contributed to India becoming a Developed Nation. Dr.Ramakrishna passed away on August 20, 2013.

Hyderabad Metro Rail as an Engineering Innovation and Urban Redesign Opportunity

NVS Reddy, IRAS

An exemplary engineer and infrastructure builder par excellence, Dr. A. Ramakrishna played a pioneering role in bringing global best practices to Indian construction industry. He was the author of several path breaking initiatives and introduced many innovative practices and construction methods for the first time in India. He introduced the system formwork in Indian construction industry which vastly improved concrete structures and raised productivity levels in Indian construction industry. A structural engineer of eminence, he pioneered application of precast, pre-stressed and tunnel form techniques which revolutionized the construction practices and uplifted the construction standards in the country. As a visionary strategist, he understood the need for close interaction between bureaucrats and technocrats; Government organizations and private business firms; and industry bodies and public institutions for the technological progress and overall development of the country.

Dr Ramakrishna was one of the early pioneers who appreciated the value of *Public Private Partnership (ppp)* mode of project development for infrastructure building in the country and pioneered several *ppp* projects executed by L&T. For his outstanding contribution to Indian construction

industry and infrastructure development, he won several prestigious global and national awards. Recognizing his pioneering role and contribution to Indian industry, Government of India posthumously awarded him *Padmabhushan* in 2014. I deem it a privilege and an honour to deliver the 2nd Dr. A. Ramakrishna Endowment Lecture to the august gathering of eminent engineers and experts this evening.

Historically, engineering provided a solid foundation for all civilizations. It provides stable structural support for a variety of systems to function efficiently and effectively. While humankind has made tremendous progress and achieved amazing success in a variety of fields, yet there are some fundamental issues troubling various nations:

- Exploding human population – a high 7 billion is likely to increase to 9 billion by 2030;
- Ever increasing human greed resulting in “difficult to sustain life styles”;
- Excessive energy consumption and wastage of fossil fuels leading to global warming and economic crises;
- Increase in social conflicts, terrorist activities and arms race;
- Increase in gap between rich and poor – both within nations and among nations.

Unfortunately policy makers and political leaders are opting for short term solutions and populist schemes rather

than tackling challenges with a long term perspective. To sustain the present rate of global growth, the world needs to spend about \$ 60 trillion by 2030. However, there is a huge gap between availability of resources and the requirement. Coming to Indian context, the scenario is even tougher. We are a rapidly urbanising nation and at the present 35% urbanisation stage itself, our cities are bursting at seams and infrastructure is cracking. The current urban population of 30 crore is set to become double in the next two decades. That is we are going to add another America for our urban population! 1/3rd of Indian urban population or 10 crore people live in slums and only 30% of urban households are connected to public sewerage system. 40% of our urban households have no piped water facility or access to toilets. There is a massive shortage of housing and affordable housing for the majority is still a distant dream. The condition of our roads is pathetic and in the absence of proper public transportation system, our urban areas are witnessing ever increasing traffic congestion and very high pollution levels. Here comes a challenge and opportunity for engineers and administrators to draw inspiration from great Indian engineering stalwarts and play a crucial role in bridging the vast gap between “requirement” and “availability”. Innovation, out of box thinking, good R&D, constant upgradation of technology, better project planning & construction practices etc., become extremely important in this context. Engineers, administrators and managers have to conceive good and

innovative projects to provide smarter and optimal solutions and execute them with out of box thinking, tight timelines and tighter budgets.

Hyderabad Metro Rail Project

Hyderabad Metro Rail project is one such path breaking attempt to provide world class infrastructure in an Indian city in an unconventional way, with a lot of financial and engineering innovation. The highly capital intensive mass transit systems across the globe are built with public funds and governments incur huge capex and offer even opex subsidies to them for the sheer survival and liveability of cities/urban areas. Out of over 200 Metro Rail systems, less than half-a-dozen are built in *Public Private Partnership (PPP)* mode and the Hyderabad Metro is the world's largest Metro project being built in *PPP* mode. The success of this model in a mass transit project is crucial for the country's infrastructure development and it will usher in a paradigm shift. Spanning over 72 km and covering three high density traffic corridors of Hyderabad city, the project cost *per se* is Rs.14,132 Cr, out of which 90% is invested by the private sector partner L&T and the balance 10% being given by Government of India as Viability Gap Funding. Together with another Rs. 2,000 Cr being spent by the State Government and a large real estate component, this Rs. 20,000 Cr project is sure to catapult Hyderabad into a higher orbit of global cities.

The challenges being faced in implementation of this mega project on the highly congested roads of Hyderabad are daunting, to say the least. We have been adopting several engineering innovations and out of box solutions to make this project happen and a few of them are as follows:

- Usage of global coordinates and DGPS for meticulous planning of alignment and execution of work;
- Every inch of the alignment is refined and finetuned several times to avoid any religious and other sensitive structures and to minimize property acquisition;
- Conversion of the project activities to 85% pre-cast mode to reduce inconvenience to road users – construction of Metro stations in pre-cast format and erecting them on central piers as balanced cantilever structures rather than portal structures has set a new global benchmark.
- Innovation in land acquisition model by making land owners and small farmers partners through land pooling to facilitate construction of a large depot and a casting yard at Uppal.
- Sleek and aesthetic piers with good finish and usage of curing compound.
- Minimizing the pier width within the confines of the road median for optimal space usage – piers occupying about 2 m at road level accommodate 2 rail tracks on the viaduct & each track is equivalent to 7 bus lanes or 24 car lanes.

- Innovative and long term solutions for road junctions with provision of longer obligatory spans and improvement in launching techniques.
- Usage of Track Master for laying track with accuracy upto 0.01mm;
- Usage of Head-hardened rails for better track safety, minimal maintenance & life cycle cost efficiency;
- Establishment of India's largest pre-cast yards at Uppal and Qutubullapur with factory like environment to ensure high standards of QA/QC.
- Usage of state-of-the-art systems and technologies including CBTC (Communication Based Train Control), a first in India; 16 field AFC (Automatic Fare Collection) systems with NFC (Near Field Communication) technology; ultra modern Rail coaches, etc.
- Eco-friendly stations with natural ventilation and commuter-friendly facilities.
- Elimination of multi-layered departmental approach of Railways & bringing in design innovation in Metro structures to enable multi-tasking.
- Advanced braking system enabling 35% power regeneration and feeding it back for utilization in the system, thereby further reducing carbon footprint.

Urban Redesign

Hyderabad Metro Rail is not being built as a simple mass transit system but is being viewed as an **urban redesign opportunity** to transform an Indian city into a people friendly and green global city. Based on the philosophy that cities are not meant for cars but are to be built for people – especially children, women, elderly and differently abled people, it attempts to cater to their special needs. I have often maintained that I am a bridge between engineers and non-engineers. I try to understand the problems and needs of different segments of society and goad engineers to work on better engineering solutions for the day to day problems that these segments face. We have incorporated multi-modal transport solution with integration of main rail, MMTS (local rail), buses and other transport modes with Metro stations to provide ‘seamless travel’ facility in the city. We are providing skywalks below the elevated viaduct to give direct landing into schools, colleges, hospitals, offices and other public and private buildings to provide safety and security; safe FoBs for Junction crossing; and to make Hyderabad an efficient city. There will be one Hyderabad at road level and another Hyderabad at elevated level. “Merry-go-round” dedicated feeder bus services, bicycles and other non-polluting last mile connectivity facilities at Metro stations, pedestrian facilities, aesthetic Metro station surroundings with lots of greenery, street furniture, public art etc., will be our contribution to the efforts to make Hyderabad a truly global city or “**Vishwanagaram**” as being envisioned by the Chief Minister of Telangana, Mr. K.Chandrasekhar Rao. Though it is still in

execution stage, this project has already got several prestigious national and global awards including “The Global Engineering Project of the Year Award” at the Global Infrastructure Leadership Forum at New York in 2013 and the ‘RoSPA (Royal Society for Prevention of Accidents) Gold’ Award at Glasgow for 2013 & 2014. Looking at the way the Hyderabad Metro project is shaping up, we are confident of establishing several global benchmarks as we have converted it from an engineer-centric transportation project to a people-centric innovation project and an urban redesign effort. It is as if by design that such a unique project is being implemented in Hyderabad and in partnership with L&T, both of which were very dear to late Dr A. Ramakrishna.

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Hyderabad Metro Rail Project

Salient features

Project

- Project cost: Rs.14,132 Cr. (\$2.27 billion)
- L&TMRHL of the \$14 billion (Rs.84,000 Cr.) L&T group is the Concessionaire
- Rs.1,458 Cr. as “Gap funding” by Govt. of India and balance investment Rs.12,674 Cr. by the Concessionaire M/s. L&TMRHL
- Additional Rs.1,980 Cr. being spent by State Govt. for land acquisition, shifting of utilities, R&R, pedestrian facilities etc.
- 3 high density traffic corridors (72 km) taken up in Phase I
 - i) Miyapur - LB Nagar (29 kms; 27 stations) within 45 min (1hr 44 min by road)
 - ii) JBS - Falaknuma (15 kms; 16 stations) within 22 min (1hr 10 min by road)
 - iii) Nagole - Shilparamam (28 kms; 23 stations) within 39min (1hr 26 min by road)
- Elevated Metro Rail on piers (pillars) with 2 metre (7 ft) ground footprint at about 30 metre (100 ft) spacing
- 10 metre (33 ft) flyover like elevated guideway accommodating two rail lines (up and down)
- Stations at an average distance of 1 km - total 66 stations at 63 locations (3 interchange stations)
- World’s largest Metro Rail Project in **Public Private Partnership (PPP) mode**
- State-of-the-art signaling system for high safety standards and frequency - CBTC (Communication Based Train Control) technology being introduced for the first time in India

Advantages

- A 3-coach train carries 1,000 passengers & 6-coach train carries 2,000 passengers. Hyderabad Metro will carry more than 50,000 passengers per hour in each direction
- Frequency of 3 to 5 min during peak hours, with cost-effective price slabs to suit common man's pocket
- 'Seamless travel' facility through integration with rail terminals, bus depots, MMTS stations & "Merry-go-round" feeder buses to nearby colonies and business areas/offices
- Video cameras in coaches and CCTVs in stations for better security
- Elegant, lightweight and air-conditioned coaches with automatic door movement - doors will open only platform side
- Sophisticated Entry & Exit gates - access through Contactless Smart Cards
- Substantial reduction in travel time with a maximum speed of 80 kmph and an average speed of 34 kmph (3 times the road speed)
- Not just a Metro, but an urban rejuvenation and redesign effort to transform Hyderabad into a people-friendly green city
- Lower energy consumption (1/5th of road vehicles) & significant reduction in air and noise pollution
- Green & eco-friendly mode of travel that reduces carbon emissions, fuel consumption & pollution
- Eco-friendly stations with natural ventilation, skywalks, ramps, escalators, elevators & a host of commuter-friendly facilities
- Metro station areas as hubs of social activity & family recreation; provision of street furniture, place for public art, bicycle tracks, greenery etc.

- Promotion of gender equality and women's empowerment
- Easy commute for children, senior citizens, differently-abled and women
- The Hyderabad Metro Rail integrates the existing rail terminals, MMTS stations, bus depots etc.
- 'Transit+': Last mile connectivity with NMT, pedestrian facilities, street furniture & quality public space

Vision



Skywalks for Connectivity & Road crossing



Vision



Greenery, Street Furniture, Bicycle Tracks, Pedestrianisation, etc.



Vision



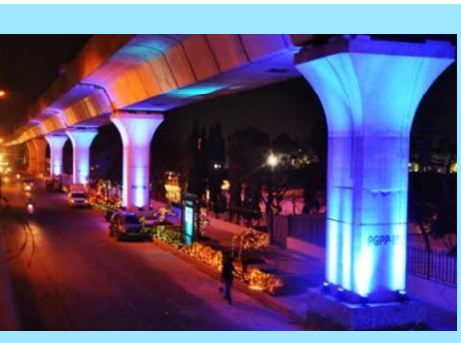
Hyderabad Metro Rail – Green Initiatives below viaduct



Vision - Result



Hyderabad Metro Rail – Green Initiatives (3,00,000 saplings planted)



Action



Translocation of Trees (2,000)



Action

Construction of Integrated School complex at Kukatpally



Before



After



Old MRO & RDO Building



New MRO & RDO Building

Construction of MRO & RDO Building at Nampally



Row of well shaped piers (pillars) of Hyderabad Metro Rail–Aesthetic look.



Aesthetic construction of Hyderabad Metro Rail elevated viaduct.



Hyderabad Metro Rail Over Head Electrification (OHE) Masts on elevated viaduct.



Balanced cantilever Hyderabad Metro Rail station resting on the central piers ('Spine and Wings' prefab construction method – allows free flow of road traffic & avoids 'tunnel' look).



Head-hardened rails for the tracks on the viaduct of Hyderabad Metro Rail (minimal maintenance & cost efficient in 'life-cycle' costing).



Track Master- A unique instrument for high accuracy of Track parameters and enhancing the quality of track installation.



Crane used for erecting Metro station roof trusses (innovative construction method to avoid crane operation from road level).



Gantry used for erecting wings of Metro station (innovative construction method to allow free flow of traffic on the road below).



The panoramic view of Uppal precast yard (72 acres- India's biggest urban precast yard).



The panoramic view of Qutubullapur precast yard (64 acres- India's second biggest urban precast yard).



A view of Hyderabad Metro Rail Uppal Depot.



Hyderabad Metro Train in station.



Test run of Hyderabad Metro train on viaduct.



Night view of the Hyderabad Metro train test run from station.



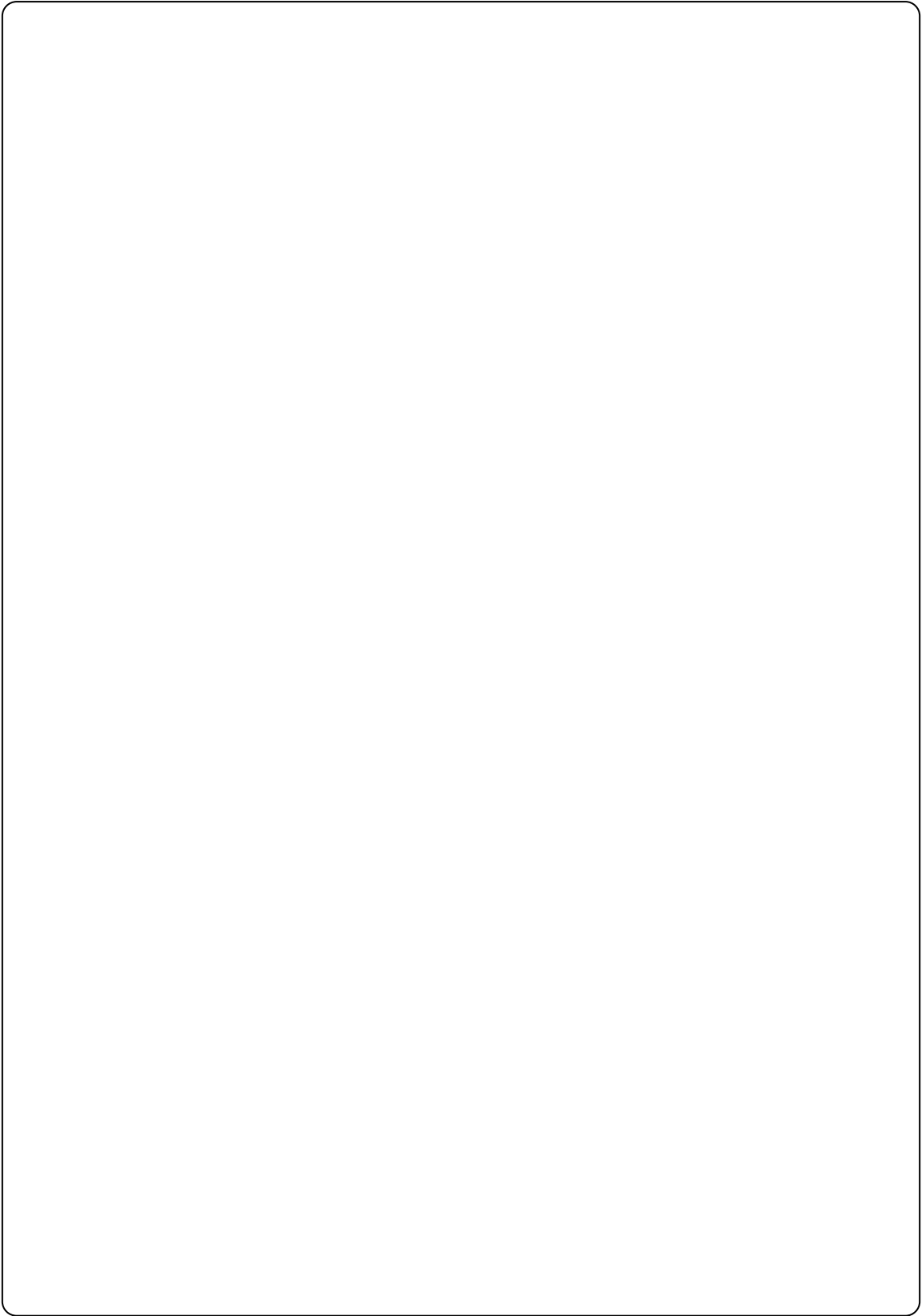
Interiors of the Hyderabad Metro train coach



Automatic Fare Collection (AFC) gates - "State-of-the-Art" Ticketing system and Passenger control



Ticket Vending Machine (TVM) at stations with different payment modes, such as Cash, Credit/Debit Cards etc.



Mr. NVS Reddy, IRAS

Managing Director,
Hyderabad Metro Rail Limited



With over 30 years of managerial and administrative experience, Mr. NVS Reddy held several senior Government positions. During his varied assignments, he contributed to systemic improvements in Indian Railways and won many awards. Later, as Director (Finance) of a power distribution company of Government of Andhra Pradesh, he successfully turned around the loss making company in a short span of one year. As Additional Commissioner of Greater Hyderabad Municipal Corporation, he built a lot of public amenities through innovative ways, without spending from public exchequer. He also built four important flyovers in Hyderabad city.

Presently as the Managing Director of Hyderabad Metro Rail Limited, he is heading the mega Hyderabad Metro Rail project (72 km). Implementation of this project with an estimated cost of Rs.14,132 crore (US \$ 2.27 billion) under public private partnership (PPP) with innovative financial engineering is his bold initiative in mass transit systems and infrastructure development. It is the world's largest Metro rail project being implemented in PPP mode.

He is known for his financial acumen, engineering innovation, open minded approach and leadership qualities. He is an expert in Rail Transportation & Power sectors, Finance, Urban Transportation, Urban Governance, Project Structuring, Project Management and PPPs. He has been associated with implementation of many important projects including the mega Konkan Rail project on the west coast of India. He has varied interests and lectures on a variety of topics in prestigious engineering and management institutes/fora in India and abroad.