Mono-Rail guided Transport

- From the 1902 Mono-Rail guided Bullock Cart in India to the 21th Century Centre Mono-Rail guided Los Angeles Automated Airport People Mover (LAX APM) in USA

Indian Steam hauled Patiala Mono-Rail (1907-1927) preserved in running Condition in National Rail Museum at New Delhi

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June 2019

From the 1902 Mono-Rail guided Bullock Cart in India to the 21th Century Mono-Rail guided Los Angeles Airport Automatic People Mover (LAX APM) in USA

I. Mono-Rail guided Carriage Transport in India from 1902 to 1927

The first Mono-Rail guided goods carriage system, a road borne railway system, had been the Kundala Valley Railway in India, which was built in 1902 and operated between Munnar and Top Station in the Kannan Devan Hills of Kerala. It operated with a cart-vehicle, built to transport tea and other goods. The initial cart road was cut in 1902 and then replaced by the monorail goods carriage system along the road leading from Munnar to Top Station for the purpose of transporting tea and other products from Munnar and Madupatty to Top Station. This monorail was based on the **Ewing System** (see below) and had small steel-wheels placed on the mono-rail track while a larger wheel rested on the road to balance the monorail. The mono-rail was pulled by bullocks. Top Station was a trans-shipment point for delivery of tea from Munnar to Bodinayakkanur. Tea chests arriving at Top Station were then transported by an aerial ropeway from Top Station 5 km (3 mi) down-hill to the south to Kottagudi, Tamil Nadu, which popularly became known as "Bottom Station". The tea was shipped 15 km (9 mi) by cart to Bodinayakkanur, then by rail via Madurai to other places in India and by ship to England.

Once-upon-a-time: Bullock hauled Mono-Rail Goods Carriage Transport in India

In 1908, the mono-rail was replaced by a 2 ft (610 mm) narrow-gauge light railway. Light steam locomotives were used to pull trains to stations at Madupatty and Palaar.

A great flood completely destroyed the Kundala Valley Railway in 1924, and the line was never rebuilt; – Source Wikipedia.

The **Ewing System** is a balancing mono-rail system developed in the late 19th century by British inventor W. J. Ewing. In the Ewing System the main wheels of the train run on a single steel rail. The system had been proposed in 1868 by William Thorold, a civil engineer from Norwich, Norfolk.

The major benefit of trains is that they run on steel tracks. Steel rail can carry more load with less rolling friction than any other mode of ground transport. However there are several disadvantages of laying conventional railway tracks consisting of two rails: Both rails have to rise and fall and bank together. Laying two rails requires a lot of space and maintenance. The turning radius of the train is restricted by the difference in length or distance traveled between the inside and outside rails due to curve resistance. Curve resistance means that the wheels on the inside rail travel a shorter distance than the wheels on the outside rail to get the vehicle around a curve. The trains can only turn to the limit where its outer wheels can cope with the additional required speed. If the outer wheels fail to maintain or reach the required speed, the train may derail.

W.J. Ewing implemented a mono-rail system, with only one rail and double flanged rail wheels, that had been proposed by William Thorold in a lecture to the British Association in 1868. This system avoided all those problems, since it was laid out along the side of a road, it took up very little land. Further, the road or balance wheel's main purpose was to balance the train and to keep it upright. The balancing wheel on the road carried only 4% or 5% of the load, it did not subtract much from the steel wheel-steel rail efficiency. As the track was on side of the road, it was no obstacle to vehicles crossing it. Further, since it was a monorail with a supporting wheel on the ground, the issue of curve resistance did not arise in Ewing System, since the wheels were placed on a single track only.

The second mono-rail in India had been the **Patiala State Monorail Tramway** (**PSMT**) in south-eastern Punjab. It was running from 1907 to 1927. PSMT was the operational locomotive-hauled railway system built using the Ewing System in the world. The Kundala Valley Railway pre-dated this, also using the Ewing system between 1902 and 1908. However this only used bullocks for haulage. Following the conversion of the Kundala Valley Railway from a mono-rail to a narrow gauge railway in 1908, PSMT was the only mono-rail system in India until its closure in 1927. These were the only instances of a mono-rail train system in India, until the Mumbai Mono-Rail was opened on 2th February 2014.

Indian Steam hauled Patiala Mono-Rail (1907-1927) preserved in running Condition in National Rail Museum at New Delhi

A steam locomotive and a coach of PSMT have been restored and are exhibited in the Indian National Rail Museum, New Delhi, in running condition; Source Wikipedia.

In the 21th Century, Centre Mono-Rail guided Driver-less/Automated People Movers (APM) running with tired wheels on a right-of-way Roll-Guide-Way, are moving passengers on many airports around the globe.

II. Los Angeles World Airport Automated Centre-Rail guided Automated People Mover (LAX APM) for the 21st Century

The Los Angeles World Airports (LAWA), USA, has an Centre Mono-Rail guided APM People Mover under construction, running with inflated Rubber Tires on an elevated right-of-way Roll-Guide-Way to connect passengers from a Consolidated Rent-A-Car Center (CONRAC) to an intermodal Transportation Facility (ITF) and then to the Central Terminal Area of the Los Angeles International Airport (LAX). The groundbreaking ceremony had been in March 2019. The anticipating Completion Date is in 2023.

The APM will be approximately two miles long and will include six stations – three in the Central Terminal Area and three outside of the airport at other LAWA facilities such as the CONRAC and ITF.

One of the three stations outside the Central Terminal Area will connect with the Los Angeles Metropolitan Transportation Authority (Metro) Crenshaw Line, creating an efficient public transportation connection to LAX.

The APM system will be fully automated and grade separated from pedestrians and other vehicles. It will be designed for passengers with luggage and allow for reliable access to the airport. Each station within the Central Terminal Area will connect to moving walkways to ensure passengers can get to their terminals quickly.

Grade separated Right-of-Way LAX Automated People Mover coming in 2023; Animation

Grade separated Right-of-Way LAX Automated People Mover coming in 2023; Animation

III. Tampa International Airport Automated Guide-Way Transit People Mover

The **Tampa International Airport People Movers, USA,** are a set of Mono-Rail guided automated people mover systems operating within the Tampa International Airport. The primary set of people movers are automated guideway transit (AGT) systems, that connect the airport's main terminal to four satellite airside concourses. Opened in 1971, it is the first automated people mover system in the world built within an airport. A monorail has run between the main terminal and the long-term parking garage since 1991. A fifth AGT line known as SkyConnect began operating in 2018, and connects the main terminal with the airport's economy parking garage and rental car center.

It uses the Mitsubishi **Crystal Mover**, a rubber-tired automated people mover (APM) system for airport and light rail applications manufactured by Mitsubishi Heavy Industries in Mihara, Japan. The **Crystal Mover** is based on the Japanese APM standard, used in six

Japanese automated guide-way transit systems including the Yurikamome and the Rokko Island Line. (Source Wikipedia)

Centre Mono-Rail guided SkyConnect APM at Tampa Airport using Mitsubishi Crystal Mover Vehicles on Roll-Guide-Way

IV. Bukit Panjang LRT Line

The Light Rapid Transit Guide-Way in Singapore is 7.6 km long. The elevated system opened in 1999. It is electrified via 600V AC third rail power. The system owner is the Land Transport Authority, but the operator is SMRT Light Rail. Two of the stations on the system connect to Singapore's metro network. It runs on rubber tired wheels and mono-rail centre guided on a roll-way. (Source Wikipedia)

Bukit Panjang LRT Line; Bombardier APM 100 Car

V. Frankfurt Airport Centre Mono-Rail guided *SkyLine* Driver-less/Automated People Mover

The Frankfurt Airport SkyLine is a free automatic shuttle rail service at Frankfurt Airport which opened 1994. Similar to the VAL system and using Bombardier CX-100 coaches, the line links the two airport terminals within 8 minutes.

The line has an headway from 90 seconds. The 60 million annual passengers of the airport and its 75,000 employees generate an annual traffic of 10 million journeys on Skyline.

The **Innovia APM 100** (formerly known as the **CX-100**) is an automated people mover (APM) rolling stock first developed by Adtranz (now Bombardier Transportation), intended mainly for airport connections and light rail transits in towns. They are operated by Automatic Train Control (ATC), making it fully automatic and driver-less.

The Innovia APM 100 is an evolution of Adtranz's previous people mover vehicle, the C-100. Bombardier's intended successor to the Innovia APM 100 is the Innovia APM 200 (originally simply known as the Innovia), which made its debut on Dallas-Fort Worth International Airport's Skylink APM. However, the Innovia APM 100 continues to be offered by Bombardier and will remain in service at many airports for years to come. In addition to being used at many airports, the Innovia APM 100 is used on the Miami Metromover, which runs throughout Downtown Miami, Florida, United States. (Source Wikipedia)

Frankfurt Airport Sky Line Centre Mono-Rail guided Roll-Way; Photograph by Mike Peel

VI. Bombardier *INNOVIA* APM 300 (C801B)

The Bombardier Innovia APM 300 (C801B) is a rubber-tyred automated people mover (APM) train to operate on the **Bukit Panjang LRT (BPLRT)**. Slated to enter service

around 2020, these will be the Bukit Panjang LRT Line's third generation of rolling stock, and will be capable of operating in single and double car formations.

Nineteen train-cars were procured by the Land Transport Authority (LTA) in March 2018.

Background

Contract 801B (C801B) for the Asset Replacement and Reliability Enhancement Works for Bukit Panjang Light Rapid Transit was awarded to Bombardier (Singapore) Pte Ltd on 7 March 2018. As part of the Contract, 19 single-car trains were procured, to replace the 19 **C801 Trains** which entered service in November 1999.

The trains will be built as part of Bombardier's *INNOVIA* family of APM trains. They are guided by a central guide-rail and draw power from a power rail embedded within the centre guide-rail. The C801B Trains will be operating on Bombardier Transportation's CITYFLO 650 system, which consists of a Communications Based Train Control (CBTC) signalling system.

Train Formation

identified by a three digit number, to be confirmed. All sets were built by Bombardier Transportation. Source Wikipedia

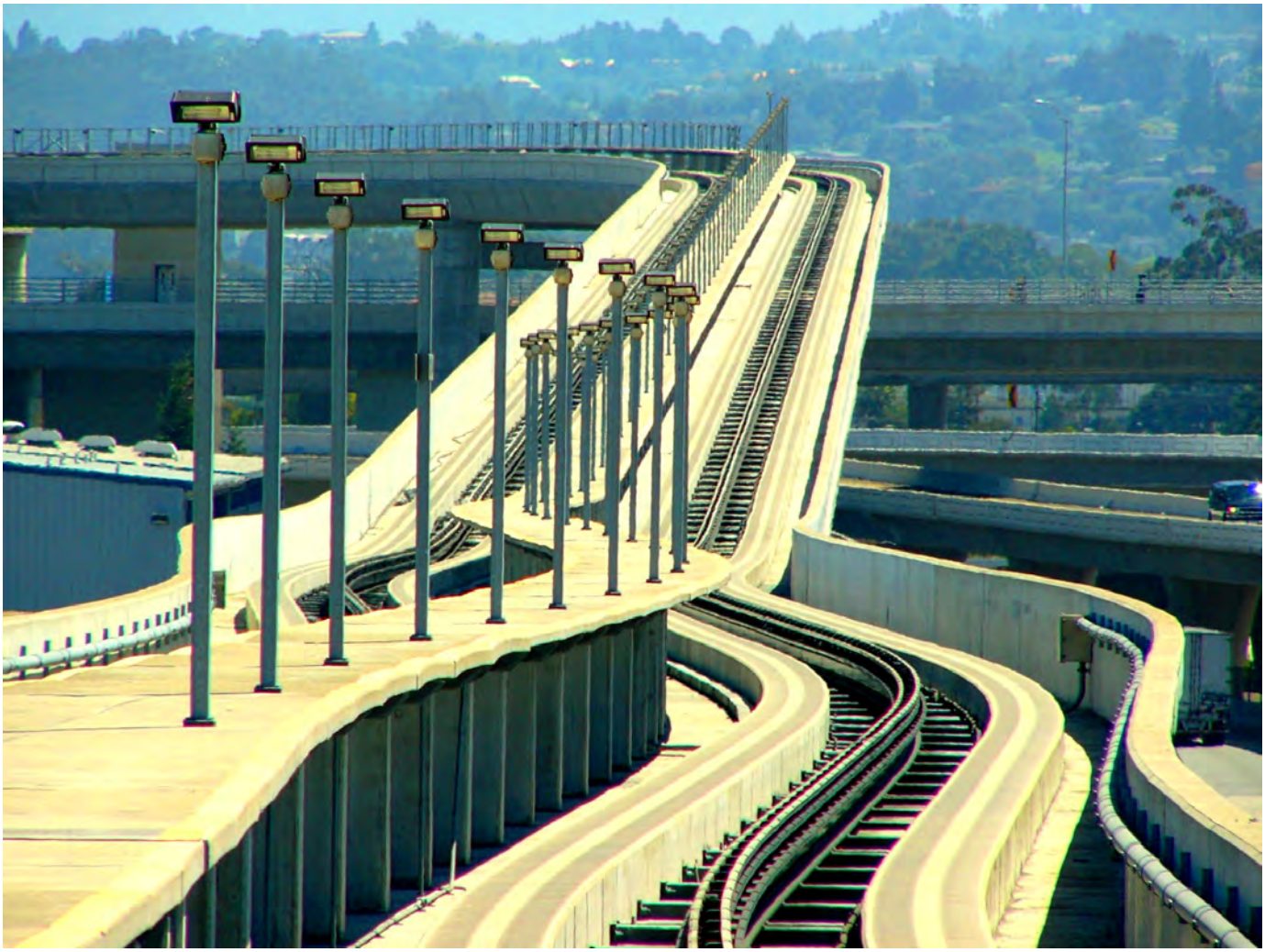
Bombardier INNOVIA APM 300 Guide-Way LRT Train-Car

Bombardier *INNOVIA* APM Centre-Rail guided and Rubber-Wheel Autonomous People Mover on Roll-Guide-Way, Shanghai

Centre Mono-Rail Guide-Roll-Way of Atlanta Airport Plane Train for new Bombardier *INNOVIA* Automated People Mover; USA

Atlanta Airport Plane Train, Bombardier ***INNOVIA*** Automated People Mover; USA

San Francisco Airtrain Bombardier *INNOVIA* 100 Centre guided People Mover



Roll Guidway of San San Francisco Airport Airtrain automated People Mover;
Pict. by Josef Poskanzer

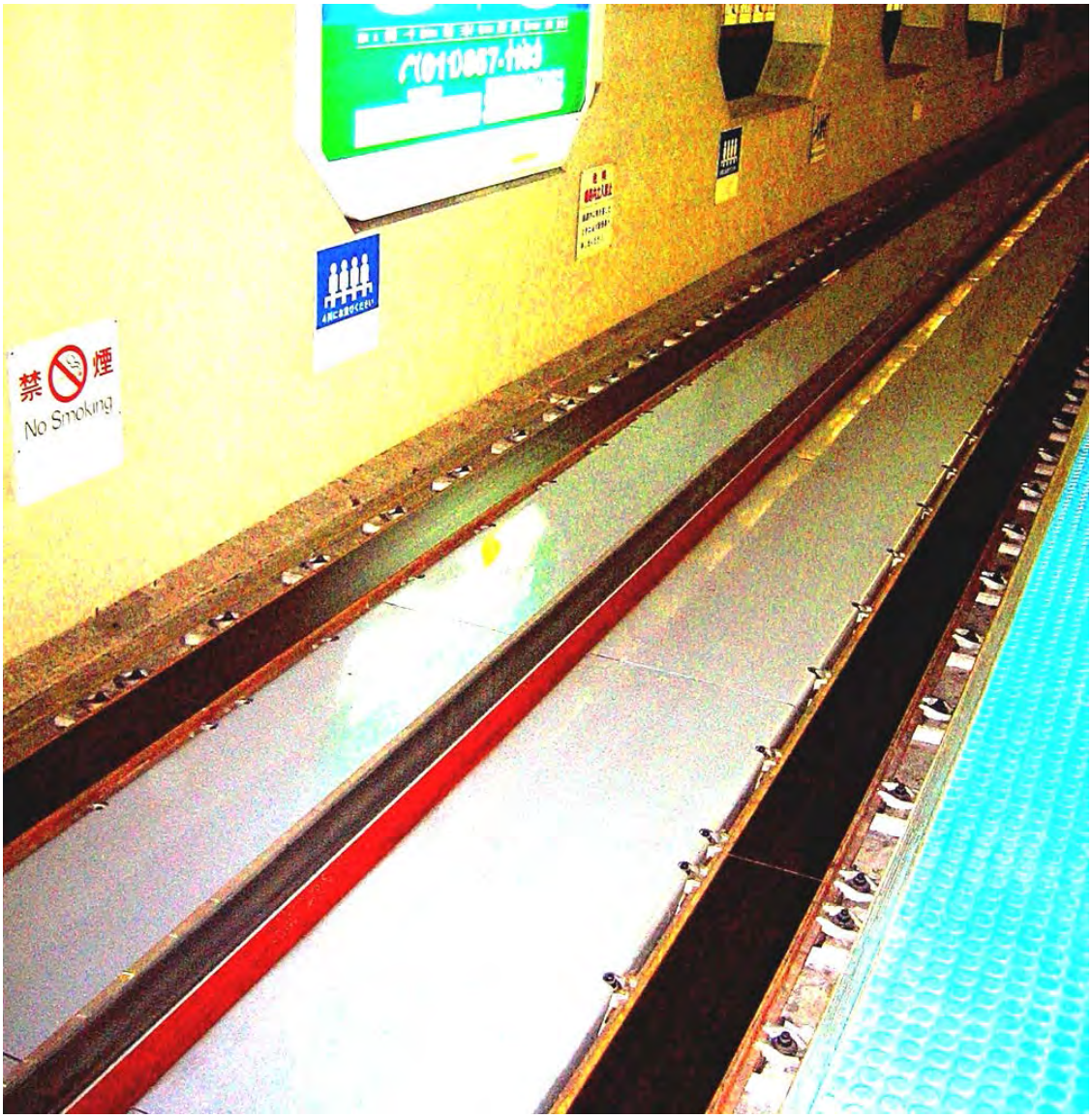
VII. Namboku Line, Sapporo; Japan

From Wikipedia

The Namboku Line is a rubber-tyred Centre Rail guided Roll-Way Metro line in Sapporo, Hokkaido, Japan. It is part of the Sapporo Municipal Subway system. Its name literally means *South-North Line*, and it runs from Asabu Station in Kita-ku to Makomanai Station in Minami-ku:

Mono Centre-Rail guided Namboku Line on Roll-Way

Centre Mono-Rail guided Car of Namboku Line



Centre Mono-Rail guided Roll-Way Track of Namboku Line

VII. Incheon Airport Linear-Induction-Motor propulsed Maglev-Suspension People Mover; South Korea

The Incheon Airport Maglev is a centre rail guided low speed 110 kmph maglev line in South Korea opened in February 3, 2016. It is the world's second commercially operating unmanned urban slow speed maglev line after Japan's Linimo. The trains are lighter, cutting construction costs in half. The majority of construction was completed by November 2012.

It links Incheon International Airport to the Yongyu Station and Leisure Complex while crossing Yeongjong island. The line is not considered part of the Seoul Metropolitan Subway. It offers a transfer to Incheon International Airport Station of AREX and is offered free of charge to anyone to ride, operating between 09:00 and 18:00 every 15 minutes. Operating hours are to be extended in the future.

This maglev line specifically utilizes electromagnetic suspension (EMS) and linear induction motor (LIM) propulsion, guided by a centre rail..

This maglev train is one of the first commercial maglev trains since the 1980s. Two more stages are planned of 9.7 km and 37.4 km. Once completed, it will become a circular line. These lines make up a core project that the Korea Rail Network Authority managed.

The Incheon Airport Centre Rail guided 110 kmph Maglev-Suspension with Linear Motor Propulsion; South Korea

VIII. Moscow Monorail; Russia

From Wikipedia

The Moscow Mono-Rail (Russian: Московский монорельс) is a 4.7 km (2.9 mi) long monorail line located in the North-Eastern Administrative Okrug of Moscow, Russia. It runs from the Timiryazevskaya via Fonvisinskaya and VDNHa metro stations to Sergeya Eisensteina street. The mono-rail line currently has six stations. Planning of the mono-rail in Moscow started in 1998. This was a unique project for Russian companies, which did not have prior experience in building mono-rails. 6,335,510,000 rubles (about US $240 million) were spent by the city of Moscow on the mono-rail construction.

It runs with Rubber Tires on an elevated Steel Beam with a Centre Guide-Rail. However, this technology of a mono-rail had not been successful.

A Moscow City government official stated in 2012 that the entire mono-rail would likely be closed and dismantled as it was unprofitable and did not perform to expectations. The same official also cited the mono-rail's poor design as another reason behind the closure plans.

Moscow Mon- Rail on a Steel Beam Centre-Guide-Way

IX. "*Twisto*" Centre Mono-Rail guided electric Urban Bus-Tram System in Caen, France

„Twisto" is the brand name under which buses and Centre Mono-Rail guided buses are operated in the Norman city of Caen. The CTAC (Compagnie des Transports de l'Agglomération Caenaise) owns the buses and has been commercialising services under the Twisto brand since 2002. Its bus depots are in Mondeville and the Industrial estate of Hérouville-Saint Clair.

"***Twisto"*** Centre Mono-Rail guided Urban Bus System in Caen, France

X. Virtuel Mono-Rail Guided City Tram-Bus-Train in Zhuzhou, China

The Tram-Bus-Train, an ART - Autonomous Rail Rapid Transit - doesn't require a track. Instead, the train-vehicle follows a marked virtual mono-rail with sensors in the road.

"Virtuel Monorail": Centre Road Sensor guided Driverless City Tram-Bus-Train in Zhuzhou, China

XI. Wuppertal *"SCHWEBEBAHN"* Suspension Mono-Rail Urban Public Transport Installation from 1901; Germany

The Wuppertal Suspension Railway (German: *Wuppertaler Schwebebahn*) is a suspension railway in Wuppertal, Germany.

Its full name is "Electric Elevated Railway (Suspension Railway) Installation, Eugen Langen System" (*Anlage einer elektrischen Hochbahn (Schwebebahn), System Eugen Langen*). It is the oldest electric elevated railway with hanging cars in the world and is a unique system.

Designed by Eugen Langen to sell to the city of Berlin, the installation with elevated stations was built in Barmen, Elberfeld and Vohhwinkel between 1897 and 1903 .

The first track opened in 1901. The *Schwebebahn* is still in use today as a normal means of local public transport, moving 25 million passengers annually (2008).

The suspension railway runs along a route of 13.3 km (8.3 mi), at a height of about 12 metres (39 ft) above the River Wupper between *Oberbarmen* and *Sonnborner Straße* (10 km or 6.2 miles) and about 8 metres (26 ft) above the valley road between *Sonnborner Straße* and *Vohwinkel* (3.3 km or 2.1 miles). At one point the railway crosses the A46 motorway. The entire trip takes about 30 minutes. The Wuppertal Suspension Railway operates within the VRR transport association and accepts tickets issued by the VRR companies. Source Wikipedia.

Two Flange Steel Wheel running on Steel Mono-Rail; electric Propulsion

Wuppertal "*SCHWEBEBAHN"* Suspension Mono-Rail Girder Installation