

Monorail System

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ABSTRACT

Considering the increase in population, increased travel demand and narrow road networks running through congested structures, there is a need of a system which will occupy less space as well as reduce travel time. With the objective, to support public rapid transit system such as suburban rail system and metro rail system and where public rapid transit system is not available or impossible to provide such system and where widening of roads is not possible due to structures on either sides, Mono Rail system is proposed to be implemented by MMRDA/GOM.

INTRODUCTION

Monorail is defined a rail based transportation system based on single rail, vehicles using the railway are either suspended from or supported by the railway and the rails acts as its sole support and its guide way [1-2]. It works under the principle of maglev (magnetic levitation). Maglev is a transport method that uses magnetic levitation to move vehicles without touching the ground. Monorails have been around since the 1800; the first monorail was made in Russia in 1820 by Ivan Elmanov, but only really came to public attention in the 1950s when Walt Disney installed one in his new theme park: Disneyland, California. Tokyo monorail one of the busiest averages 127000 passengers per day and has served over 1964 billion passengers. These are divided in two broad classes they are "straddle beam" and "suspended" monorails [3-4]. Most common type is the straddle beam in which the train straddles a steel or reinforced concrete beam. A rubber tired carriage contacts the beam on the top and both side for traction and to stabilize the vehicle.

Almost all modern monorails are powered by electric motors fed by dual third rails, contact wires or electrified channels attached to or enclosed in their guidance beams [5-6]. Monorail is raised at a minimum height of 5.5 meters from ground level on columns. It works under the principle of maglev (magnetic levitation) systems. They are highly stable and allow rapid deceleration from great speed. An alternating current is ran through electromagnet coils on the guide walls of the guide way [7-8]. This creates a magnetic field that attracts and repels the superconducting magnets on the train and propels the train forward. Braking is accomplished by sending an alternating current in the reverse direction so that it is slowed by attractive and repulsive forces [9]. At speed maglev trains hover over the track and are not in physical contact with it. Maglev trains use magnets to levitate and propel the trains forward. Since there is no friction these trains can reach high speeds [10]. It is a safe and efficient way to travel.

Salient features of Monorail system

1. In Monorail System train runs on a narrow Guideway Beam, wheels of which are gripped laterally on either side of the beam.
2. Monorail is a Light Weight System and its cost of execution is less compared to heavy rail systems and it takes approximately 1.5 to 2 years for execution.

Cite this article as: B.Parvathamma & M.Shankar, "Gas Turbines", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 5, Issue 3, 2018, Page 163-168.

3. Mono rail System requires 1.00 m wide space (Column Size 0.8 m X 1.5 m) the space of a footpath or a divider and it rests on a single pillar of height 6.5 m without disturbing the existing traffic.
4. Capacity of 4 cars Monorail System is 8000 to 12000 PHPD.
5. Monorail System can achieve $\pm 6\%$ gradient and turning radius upto 50 m.
6. As compared to other systems Monorail produces less noise and is eco-friendly and hence easily acceptable in dense residential locale.
7. Monorail System is in use in Tokyo (Japan) from 1963, in Kuala-Lumpur (Malaysia) for last 5 years and in china for last 3 years.
8. Monorail System is Safe and reliable system.

MMRDA proposes to implement a proven and established Monorail System in various parts of Mumbai Metropolitan Region (MMR). It is proposed to initially take up implementation of about 20 kms Monorail System from Sant Gadge Maharaj Chowk – Wadala – Chembur station as a Pilot Project. Completion period of the full project is 30 months.

1.1 History of Monorail

1.1.1 Early development

Its concept was developed since 1800, the first monorail was made in Russia in 1820 by Ivan Elmanov but only really came into public attention in the 1950s when Walt Disney installed one in his new theme park: Disneyland, California.

1.1.2 Suspended and bicycle railways

In 1886, the Enos Electric Company demonstrated a suspended monorail on the grounds of the Daft Electric Light Company in the Greenville section of New Jersey, which was closer in its appearance to more modern monorails, but the most famous suspended monorail of this era was floating railway, of Wuppertal (city of germany), which entered service in 1901, and is still in daily use.

From 1910–1914 a monorail system designed by Howard H Tunis was used on the Pelham Park and City Island Railroad in the Bronx, New York City as shown in below fig.1



Fig.1 Pelham Park and City island railroad in Bronx, New York City

Gyro Monorail

The only true monorail was the Gyro Monorail developed independently by Louis Brennan, August Scherl and Pyotr Shilovsky. The first true monorail is also know as brennan monorail as shown in below fig. This was a true single track train which used a gyroscope-based balancing system to remain upright. but development was effectively stopped by the First World War. For example Brennan Monorail as shown in below fig.2



Fig.2 Brennan monorail

Evolution of Monorail

Its construction was however continued and problems which are faced during the construction and operation of monorail was analysed and actual remedial measures were introduced. The time since the Second World War has been characterised by a massive expansion of road and air transport at the expense of rail. Under such circumstances, it was not surprising

that marginal rail projects, such as monorails, were first to be abandoned.

Modern era of development

The development of automotive technology has given rise to a new class of monorail which owes little to the work of Palmer and Lartigue. These vehicles are suspended from or straddle concrete beams, and use pneumatic tyres to improve adhesion and reduce noise compared with wheel on steel. They have more in common with guided buses than conventional railways. The beam is less obtrusive than an overhead roadway or railway, and the modern designs may have a niche in dealing with right of way problems in congested city centres, at lower cost compared with tunneling. Modern Monorail is shown in below fig.3 and fig 4.



Fig.3 Modern Monorail



Fig.4 Modern Monorail in Mumbai

WORKING PRINCIPLE

It works under the principle of magnetic levitation train. It requires electromagnetic current to generate magnetic field which is responsible for the acceleration and deceleration of train. Propulsion of a maglev train is explained below:

The system consists of aluminum three-phase cable windings in the stator packs that are on the guideway. This train uses superconducting electric magnets in the vehicle to levitate and propel the train. These magnets are cooled by liquid helium or liquid nitrogen. This means that once electrified these magnets do not require additional energy.

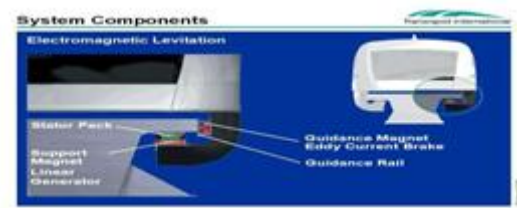


Fig.5 Monorail system components

An alternating current is ran through electromagnet coils on the guide walls of the guide way. This creates a magnetic field that attracts and repels the superconducting magnets on the train and propels the train forward. The magnets on the side keep the train from moving from side to side. A computer changes the amount of current to keep the train 1 cm from the track. Only the section of track where the train is traveling is electrified.

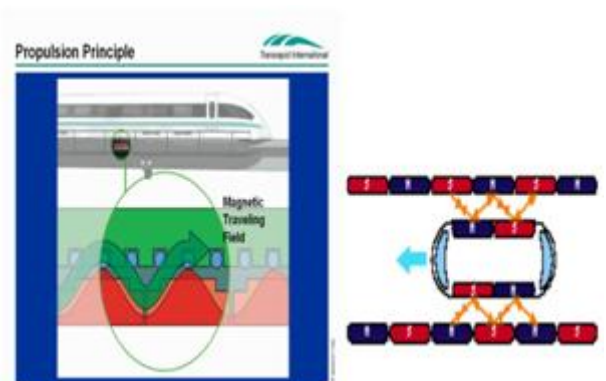


Fig.6 propulsion principle of Monorail

Braking is accomplished by sending an alternating current in the reverse direction so that it is slowed by attractive and repulsive forces. Different speeds are achieved by varying the intensity of the current.

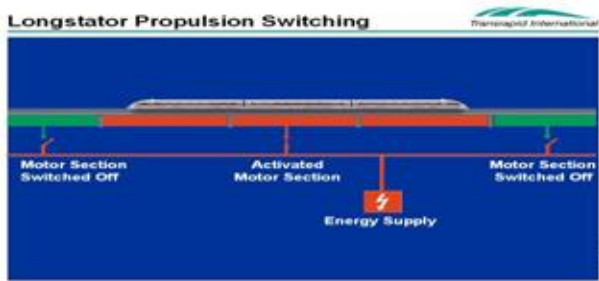


Fig.7 Long stator Propulsion Switching



Fig.8 Straddle- type monorail system

TYPES OF MONORAIL SYSTEMS:

Monorails are classified into two type of systems, they are

- Straddle type monorail system
- Suspended type monorail system
- Straddle type monorail system

Straddle type travels by straddling the track and its centre of gravity situated above the track. some features of the straddle type monorail systems are:

The construction period to deploy a monorail is far shorter than to build a subway, and the construction costs are less expensive; that is, roughly one-third for building a large monorail system and one-sixth for a small-scale monorail system.

Three scales of monorail system with different carrying capacities are available: the small straddle type monorail system has a carrying capacity of 79 passengers per car, the standard system is capable of carrying 100 passengers per car, and the large monorail system can carry up to 173 passengers per car. Having a transport capacity of 2,000 (small system) to 25,000 passengers/h (large system), they can flexibly accommodate a wide range of municipal planning needs.

Monorail vehicles with rubber tires can negotiate steep grades (6%) and small-radius curves (40-meter curves for the small monorail). Rubber tires also provide a quiet, comfortable ride for passengers.

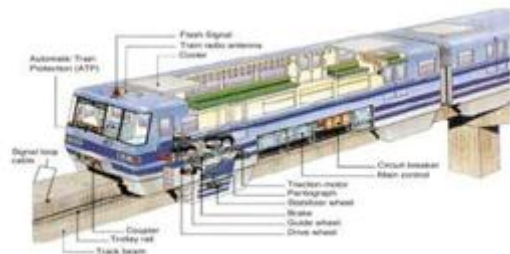


Fig.9 Straddle type of Monorail System (Components)

Suspension type monorail system

Comparing to conventional on-the-ground monorails, this suspended type takes less space. The innovative separation of its cabin and its drive unit has compactly minimized planer area occupation. Being ideally proper for installation on stairways or steep slopes in sloped residential areas or on waterways. Suspended Type Monorail has wonderfully realized the convenient door-to-door transportation of people.

CONSTRUCTION OF MONORAIL:

Process of monorail construction is simple: dig a hole, drop in a pre-built support pylon, truck in the track which was manufactured offsite, lift into place! Monorail beam way can be installed far faster than the alternatives. Below Figure shows a Las Vegas Monorail beam being put into place. From truck bed to pylons was a matter of a few minutes. The entire system took only seven months to construct. No other fixed rail can be installed as quickly and as disruption-free.



Fig.12 Simple construction process of monorail

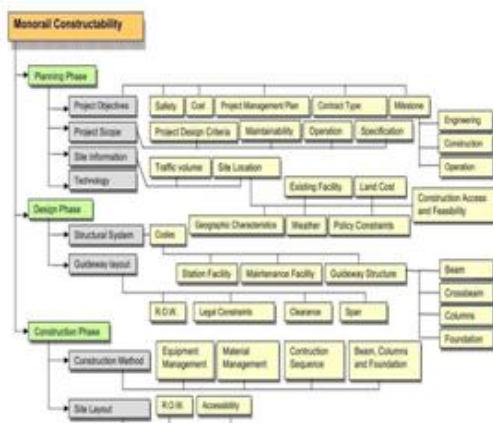


Fig.13

Influence diagram for Monorail Constructability

ADVANTAGES

- Monorail can be built faster with less cost. It consumes minimal space.
- For cities that have a population of less than three million, monorail is the ideal mode of transport. For denser cities, monorail can ideally serve as the feeder line that brings passengers in and takes them out of the Metro network.
- The monorail itself uses no carbon-based fuels and so does not pollute, unlike cars and buses.
- As monorails run around elevated tracks there is no risk of cars getting stuck on crossings.
- Monorails are also practically silent, as opposed to trains which make a noise traveling along rails.
- Monorails contribute to a greener environment as it helps in removing vehicles from the road.
- Monorails regularly operate at an amazing 99.9% reliability. No other form of transit can touch that number. The rubber tires get little wear running on smooth guide ways. Typically, each load tire gets over 100,000 miles of travel before being replaced

CONCLUSION

With the increase in the construction technology of Monorail, it can reduce the use of city buses in narrow and busy road and will provide comfort to the passengers because of its suitability in the congested areas. As it connect the arteries and veins of the city and proves to be environmental friendly it is going to replace various modes of transportation which affect environment. With the increase in the population it is necessary for the advancement of transport technology in order to provide systematic way of transportation in the near future; for which monorail can be the best alternative.

FUTURE SCOPE

With the development of monorail and its advantages over conventional rail system, monorail is the technology of the future. Monorail will be hitting the rapid construction and operation replacing the conventional system. Operation of monorail will be saving the precious fuel.

DIFFERENCE BETWEEN MONORAIL AND METRO RAIL

	MONORAIL	METRO RAIL
Type Of Use	Technology	Service
Rails	Single	Double
Expenditure	Between Rs 120 and Rs 150 crore per km	Over Rs 200 crore per km
Construction time	Between 3-4 years	Over 5-6 years
Passenger capacity per hour	10000	40000
Suitability	congested as having sharp turns	open area having no sharp turns
Cost	Rs 8 - 20	Rs 8-30
Speed (Average)	65 km/h	100 km/h
Space occupied	minimal space compared to metro rails	more area compared to monorails

Table 1 comparison between Monorail and Metrorail

With more research works going on about the monorail it can be made more advanced and more environmental friendly.

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