DETAILED PROJECT REPORT
PUDUVAI TRANS RAPID SYSTEM

Prepared By

UNITY INFRA TRANSIT PROJECT IMPLEMENTERS
JANUARY-2015

Preface

We, ***Unity Infra Transit Project Implementers*** take immense pleasure in documenting the feasibility study for the most innovative, technologically advanced, safe, green transportation project called the "Maglev Magnetic Two-tier Monorail Trans Rapid System" for Puducherry.

1-About the company

WhO is Unity Infra Transit Project Implementers

A transportation specific project implementers, has hunger in taking up more and more transportation projects in India. We are based in Chennai.

This enterprise was started in 2012.

We have 8 members in our team presently will grow as a major corporate in the years to come, headed by Mr. dhoulat sah and Mr. Heerlal guided by Dr. Smarjith Roy from UK.

(UITPI) engaged itself for preparation of the detailed project report for Over Head Maglev Magnetic Two-tier Monorail Trans Rapid System for Puducherry regional rail system. This executive summary deals with Monorail system only.

What is Puduvai trans

Puduvai Trans is the name assigned for this particular transportation project which is likely to be started in puducherry. So, it is named as ***Puduvai trans***.

Maglev Magnetic Two-tier Monorail System

Monorail systems have been the subject of future-looking visions for many years. Monorail systems do have a major drawback though, the trains can only run on the rail in one direction at a time, effectively meaning the construction and maintenance efforts for implementation take twice the cost and space. Now, a German company, ***Innovative Access Team – IAT*** Maglev has added a new dynamic to the configuration that hopes to make the transportation system even more economical and greener. The two-tiered or stacked monorail system proposed by IAT Maglev even has one of the patent owners investing 100 million Euros to the first project that will tackle the construction of the system in the next two years - regardless of the country. The company is now looking for partners to make their revolutionary new traffic system a reality. Possibly even Elon Musk might like the idea as part of his Hyper loop concept.

The two-tiered, single-beam monorail design runs with integrated implementation and locking solutions, and is intended for personal and freight vehicle traffic. Electronically controlled levitation magnets allow the railway to be suspended - without wheels, axles or overhead lines. The friction-less electro-magnetic system facilitates speeds that go beyond 300 km/h - with maximum travel comfort. The "two-tiered monorail", however, has huge advantages compared to the conventional monorail or **Trans rapid system** including CO_2 reduction, reduced sound emission (as there is no engine or friction noise). IAT Maglev is also proposing that the double magnetic system could be installed with solar panels in each 100 km track length to enables us to make the maglev environmentally friendly and cost-effectively.

The developers also claim that improved safety will result due to their automatically-run system-security vehicles that travel ahead of every personal monorail, and connected to the control

mechanisms to shut the system down in case of failure. Along with personal transport, IAT Maglev is also actively promoting their solution for the freight and logistics industry. For corporations and governments, the implementation of the magnetic monorail that investment in structural and operating costs will be markedly reduced suggests the company. This would be accomplished via the use of a beam in a two-tiered upper/lower carriageway system instead of the previous one-tiered system. IAT Maglev also claims that expensive tunnel and junction solutions would be minimized with their solution. Moreover, they say their Two-tier monorails will substantially relieve freeways and roads, taking the strain off that area of infrastructure.

The ***Puducherry Trans Rapid System*** ("***Puduvai Trans***," or the "Company"), is a new, high-tech, maglev magnetic monorail based entity focused on zero-emission, self sustaining operations, with core competencies in urban planning, passenger transportation, and smart growth. With the support of world-class strategic partners, ITA has the potential to spawn a new, global high-tech industry with compelling appeal from both a financial and environmental perspective. ITA will provide a royalty perpetual license of its proprietary technology to ***Puduvai Trans*** in exchange for such equity rights. All assets, infrastructure, marketing agreements, leases and easements will remain the property of ***Puduvai Trans*** Initially, ***Puduvai Trans*** will design, finance, build and operate a 17,195 km Sustainable Green Energy Transportation Systems utilizing licensed proprietary magnetic levitation ("maglev") technology to carry passengers between the Rajiv Gandhi bus stand to Puducherry university via end of the state entrance. Serving both the patrons parking lots and the citizens of the surrounding will provide green, seamless connectivity for up to million riders per year replacing the dozens of diesel powered buses that currently operate along this corridor on a daily basis.

The ***Puduvai Trans Rapid System*** build Two-tier maglev monorail system is our response. UITPI has proposed to build urban railway network as a backbone and to introduce nick named as ***Parakkumbus Project*** – 17.200 km of new transit network in its master plan for year 2015 has developed a plan to improve the transport system by organizing systems. Development Institute has suggested designing an inner circular route to assist to supplement the current network, which is concentrated on all the direction. The inner circular route can connect internal trip, and reduce the use of private vehicles. The proposals of new transit system introduction and necessity have been discussed, however in conceptual level, and the feasibility of the new transit in terms of economic and financial aspect has remained unstudied. Here, we define new transit as a transportation mode which has automatic guiding system with independent routes, State-Wide Two-tier Maglev Monorail System, and present a detailed proposal for the first phase which is to be built for 17.200 kms.

2-About the directors of the company

Dr. samarjith Roy. Mtech - (BRUNEL UNIVERSITY - UK).
DIRECTOR - UNITY INFRA PROJECT IMPLEMENTERS.
He is heading this project and unity infra team.
He is working as a director for City Wastes Bioenergy Solutions -UK.
Lecturer in entrepreneurial management in London.
HEADS, shows interest in executing and has sound knowledge about MANY BIOENERGY PROJECTS across the globe.
Email: ceo.cws@gmail.com

Mr. M. Dhoulat Sah.
FOUNDER, DIRECTOR - UNITY INFRA PROJECT IMPLEMENTERS.
ALSO an active member for the execution of projects under unity infra project implementers concern.
A very hardworking, effective team player, leader in real life.
Email: dhoulatsah@gmail.com

Mr. B. Heeralal Bohra.
CEO - UNITY INFRA PROJECT IMPLEMENTERS.
A very hardworking, effective team player, leader in real life.
Email: bheeralal@gmail.com

3-Why this idea?

Natural resources in India are very fastly depleting by all means due to unplanned methodologies, fast growth in population, accidents etc. So, here is a time to make use of the more readily available renewable energy resource (we use solar power) available in abundance across the world, combining with the most innovative non-polluting, noise less technology (The Maglev) for minimal expenses and maximize profits and to provide the maximum safety in all fronts in this light rail system

.

4-Why this project in India?

India is a vast and fast developing country in all economic fronts with many natural resources readily available.

Moreover, transportation plays a vital role in everyone's life in India. The population in India is heavily on the rise, where transporting people and freight by the safest means is an important challenge.

Maglev technology in rail transportation is the proven one across the world in safety, time saving, non-polluting and various other reasons at par making it the safest means of transportation I nthe world.

Other countries in the world have already changed or changing at a very fast phase towards tapping and using the different sources of renewable energies, one being the solar power.

While India is just a starter on this front.

This is the right time to combine the renewable energy resources (solar power in particular that is used in this project) and the most innovative, safe, technologically advanced transportation system to achieve the best in India.

So, ***Unity Infra Transit Project Implementers*** have started the initial phase of combining these two into one namely "Maglev Magnetic Two-tier Monorail Rapid Transit System – MMTMRTS" and very soon and the first of its kind to be implemented in India through ***Unity Infra Transit Project Implementers*** under the project name ***"Puduvai Trans"***.

5- Salient features of the project

Route Length	17.200 Km (Fully Elevated).
Number Of Stations	16 Nos. (All Elevated).
Track	Reinforced Metal Concrete Guideway.

Traffic Forecast

From	To	Rajiv Gandhi Bus stand To Puducherry State Entrance				Puducherry State Entrance To Rajiv Gandhi Bus Stand			
Rajiv Bus Stand	*Old Bus Stand*	2015	2021	2031	2041	2015	2021	2031	2041
Old Bus Stand	*Raja Theatre*	2085	2481	3325	4469	2380	2844	3825	5144
Raja Theatre	*Ajantha Signal*	3243	3859	5171	6950	2600	3107	4179	5620
Ajantha Signal	*Bell Tower*	3928	4674	6263	8417	2965	3543	4765	6409
Bell Tower	*Muthialpet*	4559	5425	7269	9769	3740	4469	6010	8083
Muthialpet	*Kottakuppam*	5029	5984	8018	10776	3466	4141	5569	7490
Kottakuppam	*China Chavady*	5167	6148	8238	11072	4052	4842	6512	8758
China Chavady	*Aurovil M Road*	2127	2531	3391	4557	900	1075	1446	1945
Aurovil M Road	*Bommayampalayam*	5017	5970	7999	10750	4957	5923	7966	10714
Bommayampalayam	*Pillaichavady*	4769	5675	7604	10219	3834	4581	6161	8286
Pillaichavady	*Engineering College*	3681	4380	5869	7888	2769	3309	4450	5985
Engineering College	*Puduvai University*	4293	5108	5844	9198	3652	4364	5869	7894
Puduvai University	*Kalapet*	5247	6244	8367	11245	3946	4715	6341	8528
Kalapet	*Ganapathi Ikulam*	1280	1523	2040	2742	762	910	1224	1646

System Design

Station Dwell Time	20 seconds.
Train Composition	Single coach (Aluminium).
Average Speed	30.0 Kmph.
Max. Speed	80 Kmph.

Traction Power Supply

Voltage	750 V dc (-375 V , +375 V).
Power Supply source	2.5MW DC power generated from solar energy.
SCADA system	Provided.

Estimated Cost (January 2015 prices)

Particulars	Estimated Cost (excluding IDC)
Without Any Taxes	893.00
With Central Taxes& State Taxes	255.00

Financial Indices FIRR

Particulars	Complection Cost	Firr%
Completion cost with taxes	1148.00	2.72%
Completion cost without taxes	893.00	5.09%

Signaling, Telecommunication & Train Control

a) Type of Signaling	Communication based train control with cab signaling and ATO – Driverless Operation possible.
b) Telecommunication	Integrated System with Fiber Optic cable, SCADA, Train Radio, PA system etc.

Maintenance Facilities

Maintenance Depot	Near Puducherry University, state entrance. (All lines Elevated).

Rolling Stock

2.44m wide 2.623 metres high modern Maglev magnetic rail car.	Single coach per train.
Net load	Less than -15 ton.
Capacity of coach unit	50 passengers depending upon car configuration and seating & standing capacity to be discussed with the car manufacturer during final design.
Class of accommodation	One
Rake requirement in 2018	12 nos

INR & $

Cost Estimate	INR	$
Total Cost	8,932,888,828	$142,252,547
Admin executive's expenses	2,187,666	$13,737,600
After the completion the project expenses	6,42,60,000	$1,023,143
After the completion the project revenue	35,04,00,000	*$5,579,135*
Advertisement Revenue	2,880,000	*$45,839*
ATM space in station Revenue	600,000	*$9,553*
Shops	2,880,000	*$45,839*
Details of Taxes and Duties	2,549,983,835	*$40,605,160*
Total project cost	***INR 1,148,000,000***	$ ***182,790,610***

Puduvai Trans Route Plan And Station Location Measurement				
No	Station Names	Area Names	Length	Chainage
1	Kurinchi	New Bus Stand	0.00	0.00
2	Malligai	Botanical Garden	935	935
3	Thamarai	Raja Theatre	718	1653
4	Culli	Ajantha Signal	931	2584
5	Vaagai	Bell tower	1010	3594
6	Nanti	Muthailpet	1027	4621
7	Maruthum	Kottakuppam	960	5581
8	Venkai	China Chavady	1102	6683
9	Mullai	Auroville	1073	7756
10	Cemmal	Boomayampalayam	1014	8770
11	Aavarum	Vanur	1036	9806
12	Alli	Pillichavady	1113	10919
13	Karanthai	Engineering Collage	1656	12575
	Depot 500 Meters	Depot	500	113075
14	Thilakam	Puduvai University, kalapet	1428	14503
15	Arumbu	Kalapet	1282	15785
16	Puduvai	Ganapathichettikulam	1410	17195

Project Plan

- The detailed project report (DPR) is likely to be submitted very early pending approval of DPR by State Government of Puducherry.
- Setting up an executing body which will take action regarding,
    - Preliminary planning.
    - Land acquisition.
    - Getting legal status for project implementation.
    - Seeking necessary Tax relieves and other clearances from the Central Government.
    - Co-ordination with utilities and other Civic and Government Body.
    - Engaging Consultants for preliminary design and Tendering.
    - Fixing of BOOT concessionaire.
- Project & Construction Management (through Consultants).
- Act as Regulatory authority during Operation and Maintenance.
- Plan for future expansion.
- Approval of DPR by Central Government. The approval is required in principle to provide legal cover and tax concessions. Provide legal cover for the project.

The project can be implemented in 4 years after sanction of the project stated above. The preliminary works can be taken up immediately after approval of DPR by the state government. Actual execution of works can start in early 2015 and commissioned in phases.

6-Concept of transportation

About hundreds of years ago there was no fastest means of transport and people had to walk on a bullock cart or horse back. Today, we are with number of means of transport and can reach any part of the world with ease. First of all, with the invention of the wheels came the cycle which is still very a popular form of transport. In fact, in China it is the only form of conveyance for the common man. It does not require any fuel and therefore, does not harm the environment. It is an eco-friendly vehicle. The first invention that made transport truly fast was the invention of the steam engine. This led to the railways. And further, the petrol engine soon changed the whole scene by making the motor car possible.

Today, of course we have motor cycles, motor cars and diesel run trucks. The bulkiest of material can easily be transported from one end of the country to other end by means of trucks or by railways. We can travel to our place of work or go on a holiday without having to worry about conveyance. Cars have emerged as the most widely accepted form of transport. Today, they have been made very comfortable to run air-conditioner, radio and tape –recorder and even a miniature television. Five or six people (or more in bigger cars such as the Mercedes and so on) can easily travel with comfort. The first reliable motor vehicle to be used as a public transport was the electric train.

On the road diesel engine were used to car heavy loads from one place to another and also to different countries often travelling hundreds of kilo metres on one journey. While travel and transport on land is easy. We have means of travelling through air as well. In 1903, the petrol engine was used to make an aeroplane engine fly. Since then of course, we have to a long way and aeroplanes have been modernized and made very comfortable for long distances travel. One can reach any foreign country not connected by land easily. Also, it can make us reach to our destination in the shortest possible time. Aeroplanes can fly at a speed of 200 km per hour – faster than the speed of the sound. Travelling a long distance is no longer considered a hectic schedule. It is now taken as a means of comfort and pleasure.

The boats have been replaced by the pleasure trips on the lakes or for short fishing trips. Ship now occupying an important place in the world of means of transport and are used extensively to transport bulky material from one country to another. they have proved a boon to industry in helping to transport material for export sand import purposes .However, while all these modern means of transport have proved to be extremely advantageous, yet there are problems associated with them too.

Petrol run vehicles emit toxic fumes and pollute the atmosphere. This has led to health problems for the citizen's. Again the large number of vehicles on the road also led to accidents which are sometimes fatal. Careless driving, or the failure of brakes, can prove disastrous. Similarly, air travel too, is not without risks. Ships have been known to catch fire owing to leakage of oil or other causes and led to the loss of men and materials on board.

Every good thing in life also has its negative points and one should try to find the solution for this. To diminish pollution, vehicles should be properly maintained and the exhaust system should be checked regularly to see that if emitting only in the limit. Further, the careful driving scan help in avoiding the accidents. Modern means of transport have thus certainly made the travelling faster and easier but it is not without hazards. Perhaps, future research and development will certainly increases efficiency and shall contribute in making our modern means of transport more safe and comfortable.

Rail transport is a means of conveyance of passengers and goods by way of wheeled vehicles running on rail tracks. In contrast to road transport, where vehicles merely run on a prepared surface, rail vehicles are also directionally guided by the tracks they run on. Track usually consists of steel rails installed on sleepers/ties and ballast, on which the rolling stock, usually fitted with metal wheels, moves. However, other variations are also possible, such as slab track where the rails are fastened to a concrete foundation resting on a prepared subsurface. Rolling stock in railway transport systems generally has lower frictional resistance when compared with highway vehicles, and the passenger and freight cars (carriages and wagons) can be coupled into longer trains. The operation is carried out by a railway company, providing transport between train stations or freight customer facilities. Power is provided by locomotives which either draw electrical power from a railway electrification system or produce their own power, usually by diesel engines. Most tracks are accompanied by a signaling system. Railways are a safe land transport system when compared to other forms of transport.

In the 1880s, electrified trains were introduced, and also the first tramways and rapid transit systems came into being. Starting during the 1940s, the non-electrified railways in most countries had their steam locomotives replaced by diesel-electric locomotives, with the process being almost complete by 2000.

During the 1960s, electrified high-speed railway systems were introduced in Japan and a few other countries. Other forms of guided ground transport outside the traditional railway definitions, such as monorail or maglev, were introduced.

7-Renewable Energy

Sources also called non-conventional energy, are sources that are continuously replenished by natural processes. For example, solar energy, wind energy, bio-energy, bio-fuels grown sustain ably), hydropower etc., are some of the examples of renewable energy sources. A renewable energy system converts the energy found in sunlight, wind, falling-water, sea waves, geothermal heat, or biomass into a form, we can use such as heat or electricity. Most of the renewable energy comes either directly or indirectly from sun and wind and can never be exhausted, and therefore they are called renewable.

However, most of the world's energy sources are derived from conventional sources-fossil fuels such as coal, oil, and natural gases. These fuels are often termed **non-renewable** energy sources. Although, the available quantity of these fuels are extremely large, they are nevertheless finite and so will in principle 'run out' at some time in the future Renewable energy sources are essentially *flows* of energy, whereas the fossil and nuclear fuels are, in essence, *stocks* of energy.

Various forms of renewable energy

Solar energy.
Wind energy.
Bio energy.
Hydro energy.
Geothermal energy.
Wave and tidal energy.

Solar energy is the most readily available and free source of energy since prehistoric times. It is estimated that solar energy equivalent to over 15,000 times the world's annual commercial energy consumption reaches the earth every year. India receives solar energy in the region of 5 to 7 kWh/m2 for 300 to 330 days in a year. This energy is sufficient to set up 20 MW solar powerplant per square kilometer land area. Solar energy can be utilized through two different routes, as solar thermal route and solar electric (solar photovoltaic) routes. Solar thermal route uses the sun's heat to produce hot water or air, cook food, drying materials etc. Solar photovoltaic uses sun's heat to produce electricity for lighting home and building, running motors, pumps, electric appliances, and lighting.

7.1-Why Solar power?

The growth of a country can be gaged directly from its growing demand for energy. If the demand for energy is not met in- time then it would severely hamper growth leading to economic meltdown and collapse. India is a developing economy with a vast potential for industrialization. However, the ever increasing energy deficit faced by the country has led to a severe economic slowdown. Apart from the industrial demand for electricity, transport sector is also a major consumer of energy in the country. This research, keeping in view the importance of transport sector as well as its energy requirements, proposes to utilize solar energy for the development of a solar powered railway transport system in the country. For this purpose, the

solar energy potential of India has been evaluated and a case study for solar powered vehicles is presented, with an aim of utilizing renewable energy resources within the country.

Generate green power

Generate electricity with energy from the sun, wind or water, producing virtually no pollution or emissions.

Gain power independence

With the use of batteries and possibly a generator as needed, you can rely on your own generating capacity, and not on the vagaries of public utilities.

Ensure uninterrupted power

With a battery backup system, you can keep your appliances running during utility power outages.

No moving parts

Solar electricity is the *only* form of energy generation that does not involve any moving part, substantially decreasing maintenance requirements and increasing reliability and long equipment life.

Solar Electricity Generation

Solar Photovoltaic (PV)

Photovoltaic is the technical term for *solar electric*. Photo means "light" and voltaic means "electric". PV cells are usually made of silicon, an element that naturally releases electrons when exposed to light. Amount of electrons released from silicon cells depend upon intensity of light incident on it. The silicon cell is covered with a grid of metal that directs the electrons to flow in a path to create an electric current. This current is guided into a wire that is connected to a battery or DC appliance. Typically, one cell produces about 1.5 watts of power. Individual cells are connected together to form a solar *panel* or *module*, capable of producing 3 to 110 Watts power. Panels can be connected together in series and parallel to make a solar *array*, which can produce any amount of Wattage as space will allow. Modules are usually designed to supply electricity at 12 Volts. PV modules are rated by their peak Watt output at solar noon on a clear day. Some applications for PV systems are lighting for commercial buildings, outdoor (street) lighting, rural and village lighting etc. Solar electric power systems can offer independence from the utility grid and offer protection during extended power failures. Solar PV systems are found to be economical especially in the hilly and far flung areas where conventional grid power supply will be expensive to reach.

Performance

The performance of a solar cell is measured in terms of its efficiency at converting sunlight into electricity. Only sunlight of certain energy will work efficiently to create electricity, and much of it is reflected or absorbed by the materials that make up the cell. Because of this, a typical commercial solar cell has an efficiency of 15%—only about one-sixth of the sunlight striking the cell generates electricity. Low efficiencies mean that larger arrays are needed, and higher

investment costs. It should be noted that the first solar cells, built in the 1950s, had efficiencies of less than 4%.

PV tracking systems

Is an alternative to the fixed, stationary PV panels. PV tracking systems are mounted and provided with tracking mechanisms to follow the sun as it moves through the sky. These tracking systems run entirely on their own power and can increase output by 40%.

Back-up systems

PV systems only generate electricity when the sun is shining the two most common methods of backing up solar electric systems are connecting the system to the utility grid or storing excess electricity in batteries for use at night or on cloudy days. For back-up through batteries, the following steps has to be set up, so it facilitates during black-out conditions.

Step 1 Find the power requirements (watts) for the appliances you need to power during a black-out.

Make a list of the loads and appliances that you absolutely need to power during an outage. Only list the essential items since the system size (and cost) will vary widely with power needed. The wattage of individual appliances can usually be found on the back of the appliance or in the owner's manual. You can use a Kill-a-Watt meter for better measurements (page 120). If an appliance is rated in amps, multiply amps by the operating voltage (120 or 240) to find watts. Add up the wattage of all the items on your list to arrive at the total amount of watts that you need to run all at the same time. This will determine the size of the dual-function inverter that you will need.

Step 2 Decide the blackout duration you want to be prepared for.

Power outages last from a portion of an hour to a day (or more). Again, this decision will greatly affect the system size and cost, so it is more cost-effective to stay on the conservative side.

Step 3 Find the amount of stored power required.

Multiply the power requirements (in step 1) by duration in hours (in step 2). The result will be in watt-hours. For instance, if you need to power 1000 watts of appliances for 2 hours, you would need to have 2000 watt-hours (or 2 kWh) of stored power.

Step 4 Calculate the power storage needed.

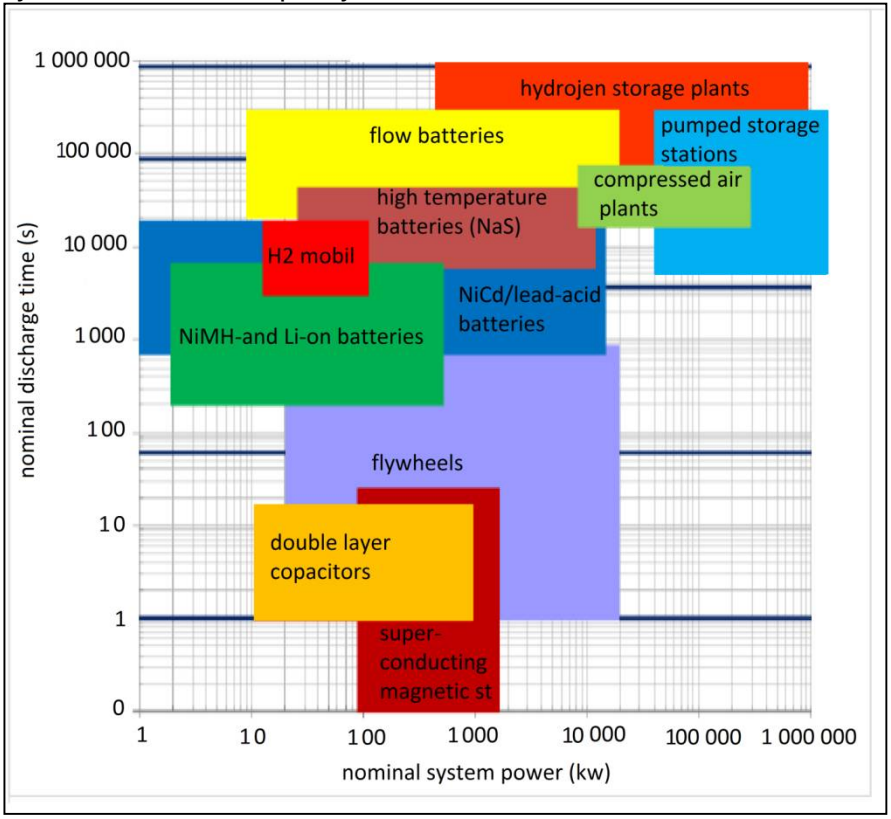
Multiply the figure arrived at in step 3 by 1.7. In the example, 2 kWh X 1.7 = 3.4 kWh of stored power needed.

Step 5 Calculate battery capacity needed.

Divide the power storage requirement needed from step 4 by the DC voltage of the system (usually 48V, but sometimes 24V) to get battery amp-hour (Ah) capacity. See the battery section on page 126 for more information on batteries. Most backup systems use sealed batteries due to their greatly reduced maintenance requirements, and because they can be more easily placed in enclosed battery compartments.

Storage Technologies - Overview

Depending on the method used to store the energy, mechanical, chemical, electrochemical, electrostatic, thermal and thermochemical storage systems are differentiated. The below image displays typical samples for their application. Storage system application areas differ for instance by capacity, duration and power.



The table above gives an overview of the power and discharge behavior of different storage systems.
These storage systems range from single elements to large compound installations.

Table: Energy storing methods and application examples

Storing method	Application
Mechanical	- Pumped storage hydro power station - Compressed air storage - flywheel
Chemical	- hydrogen, methane (by electrolysis and possibly following methanation)
Electrochemical	- battery (e.g. lead-acid, nickel-cadmium, nickelmetal hydride, lithium-ion, redox flow, sodium-sulfur, sodium nickel-Chloride etc.)
Electrostatic	- capacitor, double layer capacitor - superconducting magnetic energy storage

Thermal	- thermal energy storage (water, solid material)
thermochemical	- latent heat storage units (phase transition between solid and liquid state)

Energy storage systems can be used in public transport power grids for
- System voltage stabilization and
- Intermediate buffering of recuperated energy to save traction energy.

For purpose of voltage stabilization, the storage level is held high at all times.

If the voltage level falls beneath a defined value, the storage feeds energy into the grid. In energy-saving mode of operation, the storage level is held at a level that allows the gathering of recovered energy in vehicles during braking as well as the supply of this energy back into the power grid for traction purposes. These functions and the necessity of installing stationary storage systems in places publicly accessible result in the following basic requirements:

- high power supply and absorption,
- high charge-discharge efficiency,
- less energy losses,
- high system reliability,
- high number of charge-discharge cycles,
- compact construction with low size ratio,
- relatively low system costs and
- no improper risk to surrounding area and environment.

These requirements limit the diversity of storage media for the use in public transport power grids. Pumped storage stations and compressed air plants are inappropriate due to their dimension, stationary character and little number of charge-discharge cycles in the course of a day. Chemical buffering as hydrogene or methane is coupled with high energy losses and does not comply with the required response time. Thermal and thermochemical storages are not suitable owing to the necessity of additional equipment for energy conversion. Super conducting magnetic storages are restricted to niche applications in consequence of the early state of research and development and very high costs.
As a result, only flywheel, double layer capacitor and accumulator systems are suitable for stationary energy storing in the energy supply of public transport. These storage technologies and their applicability will be highlighted below. A survey on characteristics of storage systems is given in the Appendix of this report. The survey intentionally includes data from different sources to demonstrate data deviation and progress. Particularly novel technologies are expected to cause significant power and energy increase and cost-cutting.

Battery Storage Systems

The term battery is commonly used for both primary and secondary batteries. Secondary batteries are also called accumulators. Only these accumulators have the characteristic of being rechargeable repeatedly and therefore they are qualified for electrical energy buffering. Accumulators differ in used base materials, in structure and arrangement of components, and in

operating temperature. Batteries with low operating temperature are used in most cases. These are for instance batteries based on of lead-acid (Pb), nickel-metalhydride (NiMH), nickel-cadmium (NiCd) and lithium in various material combinations. Among these, lithium-ion (Li-Ion) batteries are expected to possess the highest potential for further development. Sodium-sulfur (NaS) and sodium-nickelchloride (NaNiCl) batteries, so called ZEBRA batteries, are known high temperature batteries. Redox flow batteries differ from others as they consist of an activity unit and spatially separated vessels for the reacting agents.

The choice of batteries possibly the biggest decision to be made if planning a solar power system of any size. Unless you are looking at a very small system, possibly using a truck battery, upgrading your battery capacity is likely to be difficult and expensive. If you are using a 24 volt battery and decide you need more storage, you will either need to replace the battery for a larger one or connect a second battery of the same size in parallel with the first. When connecting batteries in parallel however, it is important that the batteries are similar. For this reason it may not be advisable to add to the battery after you have been using the system for a while, by which time there would have been some reduction in battery performance.

Measurement of Battery Capacity

The capacity of a battery or cell is measured in amphours. A 100 amphour battery in theory can supply a current of 1 amp for 100hrs before becoming fully discharged (although a battery should never be discharged below 20% of full capacity, and on a regular daily basis should not be allowed to go below 60% capacity).
As the efficiency of a battery, and therefore it's amphour rating varies according to how quickly it is discharged, a standard discharge time is used when quoting a batteries capacity.
If a battery is quoted as having a capacity of 100 amphours (c10), that infers that it will supply 100 amphours discharged over a 10 period.
100 amphours (c100) would indicate that the battery will supply 100 amphours when discharged over a 100 hour period. For a particular battery, the c100 rating would be expected to be significantly higher than the c10 rating.

- If two batteries are connected in series, the total amphour rating will be same as each individual battery (which should be the same size).
- If two batteries are connected in parallel, the total amphour rating will be the sum of that of the two batteries.

Factors Influencing Size of Battery

Don't underestimate the size of battery required. It can be frustrating to have a system where the battery size does not give you enough stored electricity to get you through a dull day and also finding that your battery rapidly becomes fully charged on a sunny day and further output from your panels cannot be used.

Factors to Consider:

- What is your daily usage in Kw Hours. This is a little tedious to calculate but necessary.
- How reliable is your sunshine - do you generally get clear sun most days or is it much less reliable.

- How long do you expect your system to cope without sunshine.
- Do you also have a wind turbine, and if so, how reliable is the wind.
- How efficient and convenient is your backup system. If you have an efficient diesel generator that starts automatically when required, this will reduce your need for battery storage.

You will also need to consider when you might use any appliances that have a high power requirement.

Energy Storage Solution based on Battery Technology

The proposed solution is based on a battery based technology, used as the wayside energy storage device. Batteries have a long history of applications of that nature. For instance the Telecom industry has its entire network infrastructure relying on batteries to maintain service continuity in the event of voltage surges, sags or brownouts. In the utility industry, critical equipment and installations are protected against momentary power losses by inverter/batteries arrangements. Even in off-grid diesel generator applications, inverter/batteries are used to absorb peak power demands, reducing generator sizing and improve global system efficiency. The Energy Storage device is referred to as a BASS (Battery Substation).

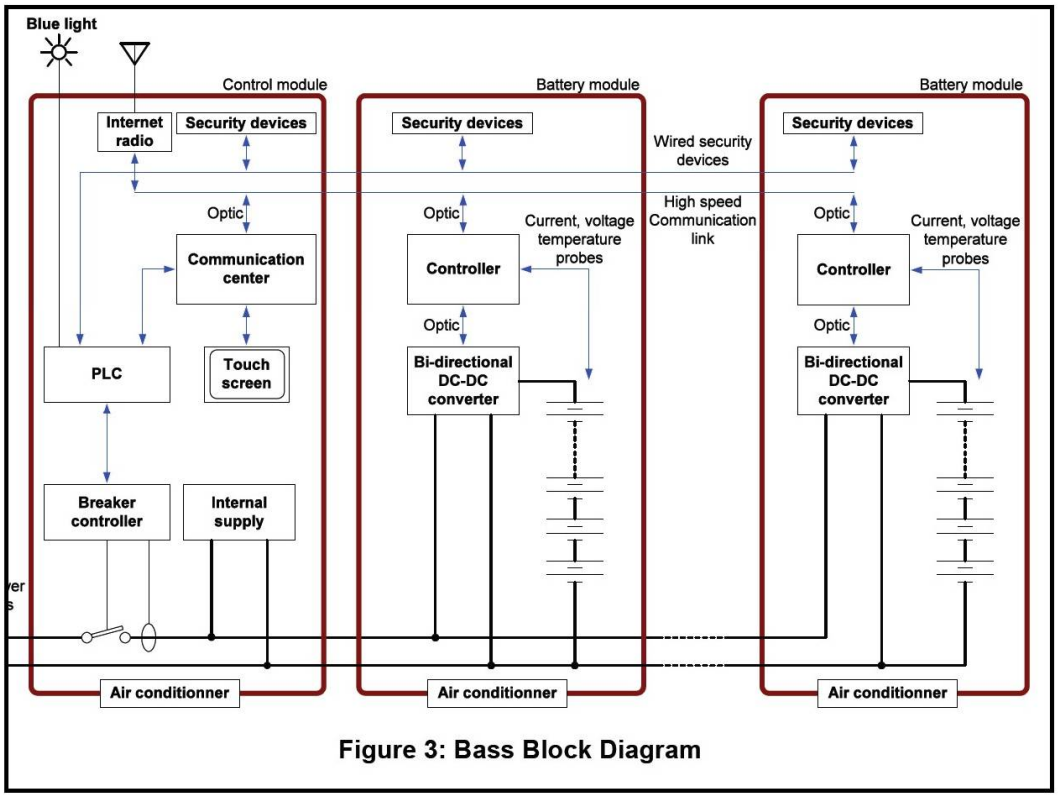


Figure 3: Bass Block Diagram

The basic requirements consist of the following:

- Wayside installation,
- Independent operation from the AC grid,
- 750Vdc operating voltage,
- 1000A power assist capability,

- 108A recharge current.

The BASS is located near a Traction Power substation to provide maximum effectiveness.

The system consists of 3 modules: one Control Module and two Batter Modules. Each of the modules is mounted in an outdoor enclosure, equipped with temperature conditioning and security equipment. The Control Module is the centre point of all internal and external communication. A user interface is provided locally through a touch screen graphical interface.

Security enabled remote monitoring is provided through the use of a wireless modem. The Power connections of the Traction Power grid are made through this module, which provides the same type of protection as a standard power substation. The Battery Module consists of Eighty (80) 12V battery blocks, for a nominal voltage of 750Vdc. The discharge current capacity per Battery Module is 500A, for a total system capacity of 1000A.Connection to the Traction Power Grid is through a charge/discharge power converter, also referred to as a bi-directional DC-DC converter. The converter ensures that the batteries provide current even if the voltage is lower than the grid voltage. As batteries can be sensitive to the level of recharge current, the converter will also limit this current to acceptable levels.

Battery Selection Process

Identifying the correct battery technology for this application is a challenge. In this particular case, the system must be capable of providing energy bursts lasting 20 seconds (power Assist), and re-charge for approximately 7.2 minutes. As well, these cycles are repeated numerous times during the day. Taking into account the train schedule run rate, it is estimated that there will be over 160 discharge/charge cycles each day. There are many choices of battery technologies available. Selection had to be based on the application requirements.

The most critical selection parameters were judged to be the following:
1. High discharge current as the critical issue with this site is to maintain the grid voltage, providing the energy in a short amount of time (power assist) is essential.
2. Relative low initial cost Capital investment is always a concern. Despite cost of ownership benefits, initial investment will always be the key deciding factor. Therefore a technology that provides a lower investment will be preferred.
3. Cost of replacement, since the number of battery modules will be high, care has to be Given to the ease of replacement, accessibility to replacement stock and recycling.

As well, this specific application did not lend itself to regenerative energy management. Therefore, capturing a high level of energy in a short amount of time was not an important selection criterion. Different battery technologies were therefore evaluated, based on these criteria, and the results are presented in Table.

Alternative Power Source

An alternative to utilizing batteries (remote power storage) is to use the power grid for power storage. You could feed the surplus generated power (during times of most intense sun) into the municipal power grid. Power could be converted to Ac and fed into the power grid. Feeding power into the grid would spin the meter backwards. During hours of darkness, power would be drawn from the grid instead of added. As you use that power that was previously fed into the grid, the supply meter spins forward (eventually back to where it was before power was deposited into the system). Essentially you could use the power grid as your battery.

- Nickel Cadmium batteries probably offer the best all around performance, but its cost is very high and the number of suppliers are limited.
- Nickel Metal Hybride batteries also offer interesting performance features, but again, its cost is prohibitive.
- Lithium Ion Phosphate technology offer very promising cost and feature parameters, but it is a fairly new technology with a limited amount of manufacturers. Although very popular in some applications.
- The Lithium Ion technology was not considered due to its higher internal resistance and therefore inability to provide high peak currents.
- **Sealed lead acid batteries were selected**. Since the type of load application is unchartered territory for most of these technologies, it was felt that it was a great opportunity to verify the performance of this battery in a high load cycling environment. Given that optimal working conditions are required to optimize the battery operatingenvironment, the following parameters will need to be controlled.

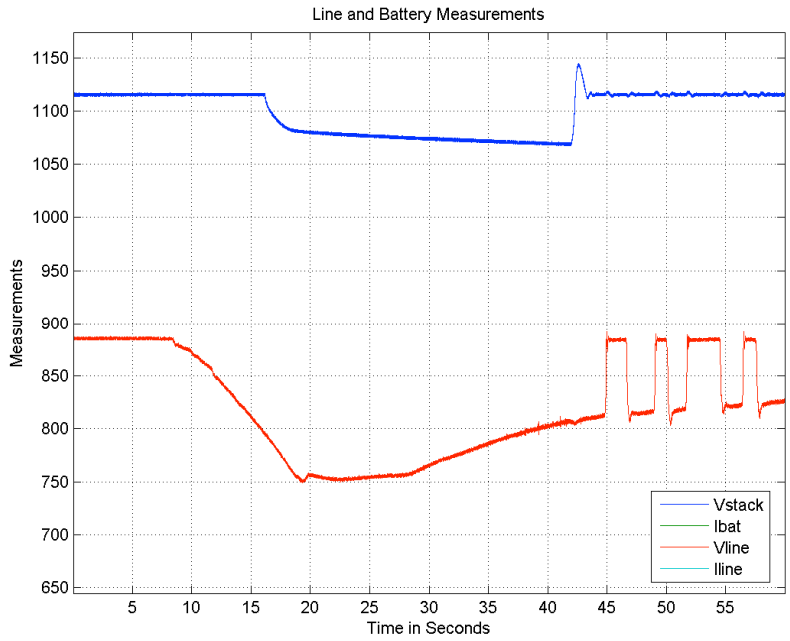
Depth of Discharge (DOD) The Dept o Discharge has a direct impact on battery life expectancy. The greater the average depth of discharge, the shorter the cycle life. In our case, with a power assist period of 20 secondsat500A, the Ah used is 20s / 3600sec/hrs* 500A = 2.8Ah. This corresponds to a DOD facto of 1.8%, which is very low and will have minimal impact on battery life expectancy.

- Battery Temperature The battery temperature is another important factor for the life evaluation. This adverse effect begins as the temperature is above 25C typically, battery life can be reduced by as much as 25% @ 30C and 50% @ 40C. As well, a factor often neglected is the battery efficiency, which induces self heating. The battery charge / discharge average efficiency is 90%*. This means that 10% of the power processed by the battery is lost in heat. Assuming 3m battery internal impedance, 750W of heat is generated @500A. The internal BASS ambient temperature is 25C but the internal temperature of the battery will be higher. The batteries are close one to the other creating a concentration of hot air surrounding the batteries. The battery temperature is dependant of the air flow from the air conditioning system. The final temperature of the batteries in the BASS system will be known in field. Fans could be added and even the internal ambient temperature can be lowered to cool down the batteries.
- Equalization and Cell Balancing Equalization is required to balance equally or adjust the State of Charge (SOC) of all batteries and cells to the same level. This is achieved by overcharging the batteries for a 12 to 24 hours time period. Equalization helps the battery to recover some of the

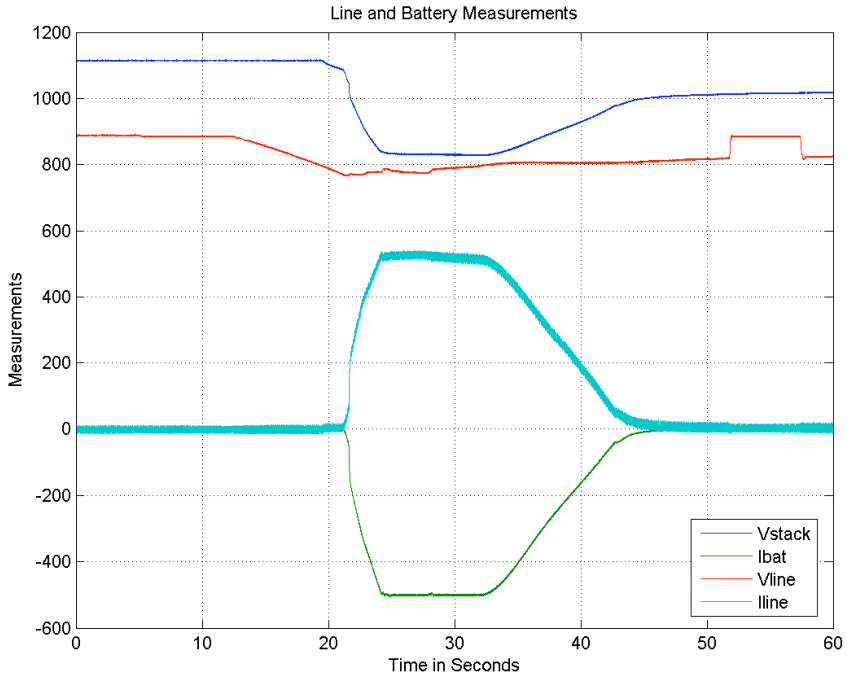
lost capacity originated from preceding deep discharges. The sulfate deposits on the internal lead plates will detach during equalization and the battery recovers some Lead surface and thus some capacity. This process has, however, a downside effect, as hydrogen generation or 'gazing' the batteries will occur. The gazing creates electrode degradation and shortens the Battery life. Therefore, equalization cycles must be well managed. If a string of batteries is not balanced i.e. all cells are at the same SOC, overcharged cells may occur during string charge because the total string voltage is considered. Inversely, a deep discharge of lower SOC cells may happen during discharge. The use of a balancing circuit will help reducing the number of required equalize cycles. A balancing circuit helps preventing cell voltage differences induced by self discharge and capacity difference. The balancing is done either by using power resistors that dissipate energy from the more charged batteries to reach the less charged batteries or by the use of DC converters that slowly discharge more charged batteries to into the lower SOC battery.

*: reference Exide Battery Corporation.

The below figure shows the grid voltage decreasing to 750Vdc during the train acceleration without BASS.



The below figure shows the voltage at the same location, with the BASS connected.



The Circuit behaves as follows:

- The nominal voltage is at 750Vdc.
- The train starts to accelerate. The current is supplied by the Traction Power Station and its voltage starts to decrease.
- When the voltage reaches 800Vdc, the BASS detection circuit activates the power circuit: the batteries start providing current until its current limit is reached (approximately 500A per battery module).
- After approximately 10 seconds, the train reaches reduces its acceleration, the current starts decreasing until the train reaches its cruising speed. At that time, no more current is required.

Solar powered transportation

At global level, the transport sector accounted for 27% of the total world delivery energy in 2008 and produced 13.4% of the total green house emissions. As already mentioned in the preceding sections, the situation is more critical in the case of India where more percentage of the total petroleum oil consumption was in the transport sector. The interest into solar energy for electric vehicles dates back to late 1970's driven by the global energy crisis as well as environmental issues. From the environmental perspective, solar vehicles provide the best available option with the existing technology offering direct conversion of light to electricity, with zero emissions at operational level. As a result, there are no green- house gas emissions with solar panels and the energy payback period is ranging from 1 to 2 years depending on the panel technology used. In this context, thin film technologies generally have energy pay back less than a

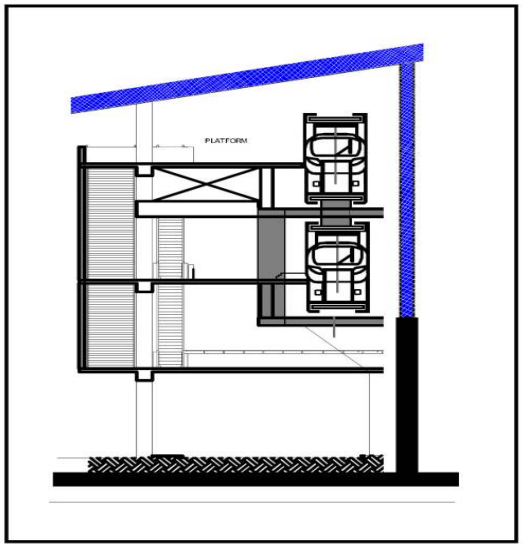
year with traditional C–Si technology having closer to two years, with over all panel life of 25 years.Therefore, the usefulness of this technology is immense since it tackles two of the world's major problems in energy and environment, collectively. This is a unique property in itself and makes it vital for our future growth. The alternatives like hydrogen based vehicles must rely on an energy source to produce hydrogen like electrolysis, thus the source of that energy comes into question. Fossil fuels, on the other hand, are all non- renewable and detrimental to the environment.

Since our project makes use of the solar electric power to run the total system, let us see about the basics involved in this and how we make use of this technology for our project.

A solar powered urban railway system

While urban rail based transit system is not a new concept, the implementation of solar power on such a system is indeed on considerable research interest. For this purpose, the infrastructure that must be developed in compatibility with the system requirements. Therefore, an existing underground railway system may not be feasible for the implementation of PV powered drives. It was proposed earlier that an effective transit system utilizing solar energy should be well exposed to solar in solution and must therefore be well raised to avoid shadowing by adjacent structure and buildings. In case of India where there are not too many tall buildings (due to building regulations within the city) and in ideal location/position (geographically) to get best solar energy share, use of solar powered urban railway system can become a reality.
24hr power can be derived from the solar power system by utilizing a battery array. Such an array could be built at convenient remote locations. The need for any "static power converters" changing "AC" power to "DC" power for the Maglev Two-tier Monorail systems would be completely eliminated.

Since the vehicles are largely "free coasting" once set into motion, this peak power demand will only occur when the vehicle is starting from a dead stop.



Puduvai Trans solar panel roof top interior

Salient features of the proposed system

The transport system envisaged in this research incorporates light weight, DC electric powered railway carriages with guideway mounted solar panels to provide for trickle charging during operation. Since the transport will run on fixed tracks with pre-designated stops, each station can be equipped with solar charging stations. Off board charging canals incorporated during operation through the provision of cater nary wire the third rail. Regenerative braking based on gravity will be utilized for simplicity as well as weight/cost reduction. Each stop will therefore be in the form of an elevated station where commercial centres can be housed at lower levels (as shown in Fig.).*Schematic of proposed gravitational braking system showing commercialization aspects.*The capital generated from the associated economic activity can then be utilized for the maintenance of the infrastructure.

Conclusions

India, like other developing countries, is facing an acute shortage of energy. The situation is more serious in case of India as the economic growth is adversely affected by this shortage of energy (both in the form of electricity and fuel). Ground transport sector consumption is one of the major loads on the energy supply of the country and the potential for solar PV transport is huge which needs to be added to other mass transit systems in the country. The ailing economy of India can no longer support the ever increasing demand for energy and the transport sector can aid in direct contribution towards the economic growth. Therefore, the proposed solution is a solar powered mass transit system (like railway) to firstly reduce the overall number of vehicles in the country, thereby reducing energy supply and demand situation and secondly improving quality of life through reduced environmental pollution. The fuel saved from transport sector, which is a huge burden on the fragile economy, can be diverted to the power generation units to provide electricity to the local industry to increase the country's GDP, job creation, economic prosperity and social uplift of the people of Puducherry, India.

8-The Maglev

Magnetic levitation (maglev) is an innovative transportation and is a highly advanced technology. It is sometimes said to be the first fundamental innovation in the field of railroad technology since the invention of the railway. The most important usage of magnetic levitation is in operation of magnetically levitated trains. Magnetically levitated trains are undoubtedly the most advanced vehicles currently available to railway industries. The Maglev Magnetic Two-tier Monorail train uses non-contact magnetic levitation, guidance and propulsion systems and has no wheels, axles and transmission. The replacement of mechanical components by wear-free electronics overcomes the technical restrictions of wheel-on-rail technology. Compared with traditional railways, Maglev Magnetic Two-tier Monorail systems have features that could constitute an attractive transportation alternative, since Contrary to traditional railroad vehicles, there is no direct physical contact between Maglev Magnetic Two-tier Monorail vehicle and its guideway. These vehicles move along magnetic fields that are established between the vehicle and its guideway. Conditions of no mechanical contact and no friction provided by such technology makes it feasible to reach higher speeds of travel attributed to such trains.

1. High Speed
2. High Safety
3. Less Pollution
4. Low Energy Consumption

Project Motivation

Magnetism has fascinated humans for centuries. So we were looking for a project based on the concept of magnetism. The idea for this project came after discussing with the coordinators and reading a Scientific American Article that described proposed Maglev Magnetic Two-tier Monorail systems around the world and their potential for future travel.

Theory of Operation

Maglev Magnetic Two-tier Monorail is defined as a “family of technologies in which a vehicle is suspended, guided, and propelled by means of magnetic forces”. It consists of two parts:
1. Propulsion System.
2. Levitation System.
1. The propulsion system used is known as a linear motor. Unlike a conventional motor, a linear motor creates linear motion instead of circular motion. As mentioned above, the major principle behind its operation is magnetic repulsion.
2. Magnetic levitation (maglev) is a highly advanced technology. The use of **magnetic** fields to suspend an object above another object without solid mechanical support. The common point in all these applications is the lack of contact and thus no wear and friction. This increases efficiency, reduce maintenance costs and increase the useful life of the system. The magnetic levitation technology can be used as a highly advanced and efficient technology in the various industrial. There are already many countries that are attracted to maglev systems. Maglev vehicles use noncontact magnetic levitation, guidance and propulsion systems and have no wheels, axles

and transmission. These vehicles move along magnetic fields that are established between the vehicle and its guideway.

Our Project makes use of this technology

Maglev Magnetic Two-tier Monorail

Maglev Magnetic Two-tier Monorail suspension system is divided into two groups of ElectroMagnetic Suspension (EMS) and ElectroDynamic Suspension (EDS). There are varieties of vehicles that are manufactured based on these two types of systems. Vehicle path in EMS and EDS systems are called guideway and track, respectively. Basically, there are two main elements in a Maglev Magnetic Two-tier Monorail system including its vehicle and the guideway. The three primary functions in Maglev Magnetic Two-tier Monorail technology are levitation, propulsion, and guidance. Magnetic forces perform all of these. Magnets are used to generate such magnetic forces. For EMS systems, these magnets are located within the vehicle while for EDS systems magnets are located in the track.

Electromagnetic Suspension Systems (EMS)

The electromagnetic suspension EMS uses attractive force system to levitate. The train's levitation magnet will be attracted to the conductors on the underside of the guideway. The attractive force between them will overcome the gravitational force. This will in turn levitates the train on the track.

The guidance magnets on the other hand guides the train so that the side of the track will not have contact with the train, creating friction and damages the train. The guidance magnets will also guide the train so that it will follow the direction of the guideway track.

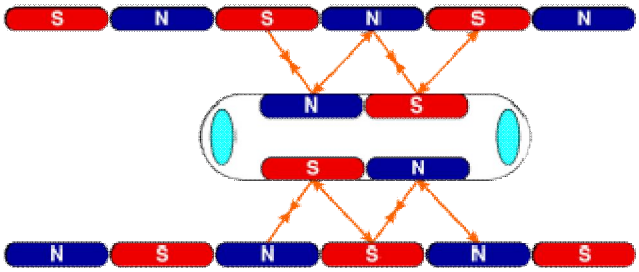
Electrodynamic Suspension Systems (EDS)

The electrodynamic suspension (EDS) train has been developed by Japanese engineers. It uses magnets that has same polarity (refer to figure above) to create repulsive force between levitation magnet and guideway magnet. This repulsive force then will be high enough to overcome gravitational force and allows it to levitate.

EMS & EDS - Difference

The main difference between EDS maglev train and EMS maglev train is that EDS maglev train use super-cooled, superconducting electromagnets. This superconducting electromagnet can conduct electricity even after the power supply has been shut off for example in the event of a blackout. In the EMS system, which uses standard electromagnets, the coils only conduct electricity when a power supply is present. By chilling the coil at frigid temperatures, Japan's EDS system saves energy. However, the cryogenic system uses to cool the coils can be expensive.

Magnetic Levitation or Maglev Propulsion



An EMS system can provide both levitation and propulsion using an on board linear motor. The polarity of the stators (Figure 1) at the track will quickly change its polarity continuously to move the Maglev train. Stators at the sides are excited sequentially. The electromagnets onboard 'chase' the current forward along the track. The continuous magnetic field moving forward. Speed controlled by frequency of alternating current.

The process of propulsion for EDS is same as EMS except that the stators will stop for a moment after polarity change. Referred as "pull- then neutral- then push" system. Coils or Aluminum sheet at the sides. The direction of current of the particular segment is reversed. Polarity of that segment changes which causes repulsion.

Propulsion coils on the guideway are used to exert a force on the magnets in the train and make the train move forward. The propulsion coils that exert a force on the train are effectively a linear motor. The linear motor in the guideway functions just like a conventional electric motor with its stator cut open and stretched out over the length of the guideway. Instead of a magnetic rotary field, the current in the windings generates a magnetic field of travelling waves, which pulls the vehicle without contact. By changing the intensity and frequency of the driving current, speed and thrust can be continuously adjusted. When the motor is operated as a generator, the direction of the energy flow is reverted and used for contactless braking.

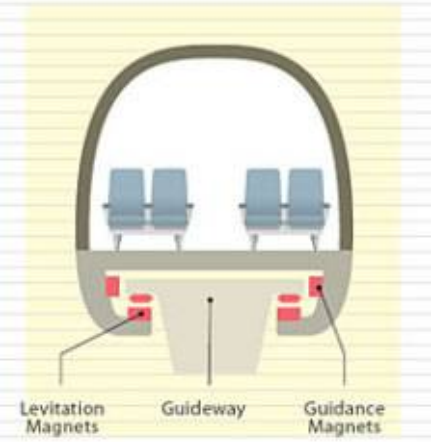
An alternating current flowing through the coils generates a continuously varying magnetic field that moves forward along the track. The frequency of the alternating current is synchronized to match the speed of the train. The offset between the field exerted by magnets on the train and the applied field create a force moving the train forward.

A linear motor or linear induction motor is essentially a multi-phase alternating current (AC) electric motor that has had its stator "unrolled" so that instead of producing a torque (rotation) it produces a linear force along its length. The most common mode of operation is as a Lorentz-type actuator, in which the applied force is linearly proportional to the current and the magnetic field ($F = qv \times B$).

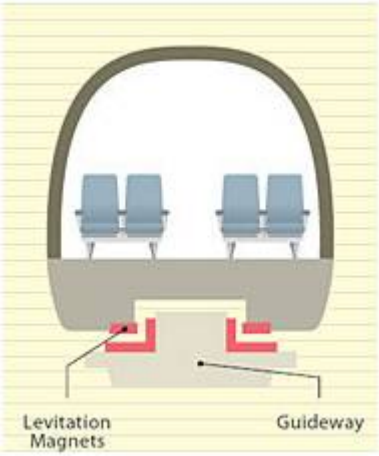
Many designs have been put forward for linear motors, falling into two major categories, low-acceleration and high-acceleration linear motors. Low-acceleration linear motors are suitable for maglev trains and other ground-based transportation applications.

The force is produced by a moving linear magnetic field acting on conductors in the field. Any conductor, be it a loop, a coil or simply a piece of plate metal, that is placed in this field will have eddy currents induced in it thus creating an opposing magnetic field. The two opposing fields will repel each other, thus forcing the conductor away from the stator and carrying it along in the direction of the moving magnetic field.

Free body diagram of a U-channel linear motor. The view is perpendicular to the channel axis. The two coils at center are mechanically connected, and are energized in 'quadrature' (with a phase difference of 90° (π/2 radians)). If the bottom coil (as shown) leads in phase, then the motor will move downward (in the drawing), and vice versa.



Electromagnetic Suspensions



Electrodynamic Suspension

Advantages of Maglev

- High speed but, safe.
- It doesn't have moving parts as conventional trains do, and therefore, the wear and tear of parts is minimal, and that reduces the maintenance cost by a significant extent.
- There is no physical contact between the train and track, so there is no rolling resistance. While electromagnetic drag and air friction do exist.
- Absence of wheels, no deafening noise.
- Environment friendly, as they don't resort to internal combustion engines.
- Are weather proof, which means rain, snow, or severe cold don't really hamper their performance.
- Experts are of the opinion that these trains are a lot safe than their conventional counterparts as they are equipped with state-of-the-art safety systems, which can keep things in control under any situations.

Disadvantages of Maglev

Biggest problem with the maglev trains: the high cost incurred on the initial setup.

Maglev in other countries

- France: (Rail network name: Train a grand vitess). Began opertions in 1980s.

- Japan: (Rail network name: The shinkansen long distance trains-Bullet train).

Also US, Europe are the leading countries that are getting benefitted day by day by this innovative means of rail transportation system. With means of least number of accidents in the world and considered one of the most safest means of transport in rail engineering.

9-Technology used in our project

9.1- Renewable energy – Our power source

Sources also called non-conventional energy, are sources that are continuously replenished by natural processes. For example, solar energy, wind energy, bio-energy, bio-fuels grown sustain ably), hydropower etc., are some of the examples of renewable energy sources. A renewable energy system converts the energy found in sunlight, wind, falling-water, sea waves, geothermal heat, or biomass into a form, we can use such as heat or electricity. Most of the renewable energy comes either directly or indirectly from sun and wind and can never be exhausted, and therefore they are called renewable.

However, most of the world's energy sources are derived from conventional sources-fossil fuels such as coal, oil, and natural gases. These fuels are often termed **non-renewable** energy sources. Although, the available quantity of these fuels are extremely large, they are nevertheless finite and so will in principle 'run out' at some time in the future Renewable energy sources are essentially *flows* of energy, whereas the fossil and nuclear fuels are, in essence, *stocks* of energy.

9.2 Solar power

The growth of a country can be gaged directly from its growing demand for energy. If the demand for energy is not met in- time then it would severely hamper growth leading to economic meltdown and collapse. India is a developing economy with a vast potential for industrialization. However, the ever increasing energy deficit faced by the country has led to a severe economic slowdown. Apart from the industrial demand for electricity, transport sector is also a major consumer of energy in the country. This research, keeping in view the importance of transport sector as well as its energy requirements, proposes to utilize solar energy for the development of a solar powered railway transport system in the country. For this purpose, the solar energy potential of India has been evaluated and a case study for solar powered vehicles is presented, with an aim of utilizing renewable energy resources within the country.

Generate green power

Generate electricity with energy from the sun, wind or water, producing virtually no pollution or emissions.

Gain power independence

With the use of batteries and possibly a generator as needed, you can rely on your own generating capacity, and not on the vagaries of public utilities.

Ensure uninterrupted power

With a battery backup system, you can keep your appliances running during utility power outages.

No moving parts

Solar electricity is the *only* form of energy generation that does not involve any moving part, substantially decreasing maintenance requirements and increasing reliability and long equipment life.

9.3- Land Acquisition

Land for depot

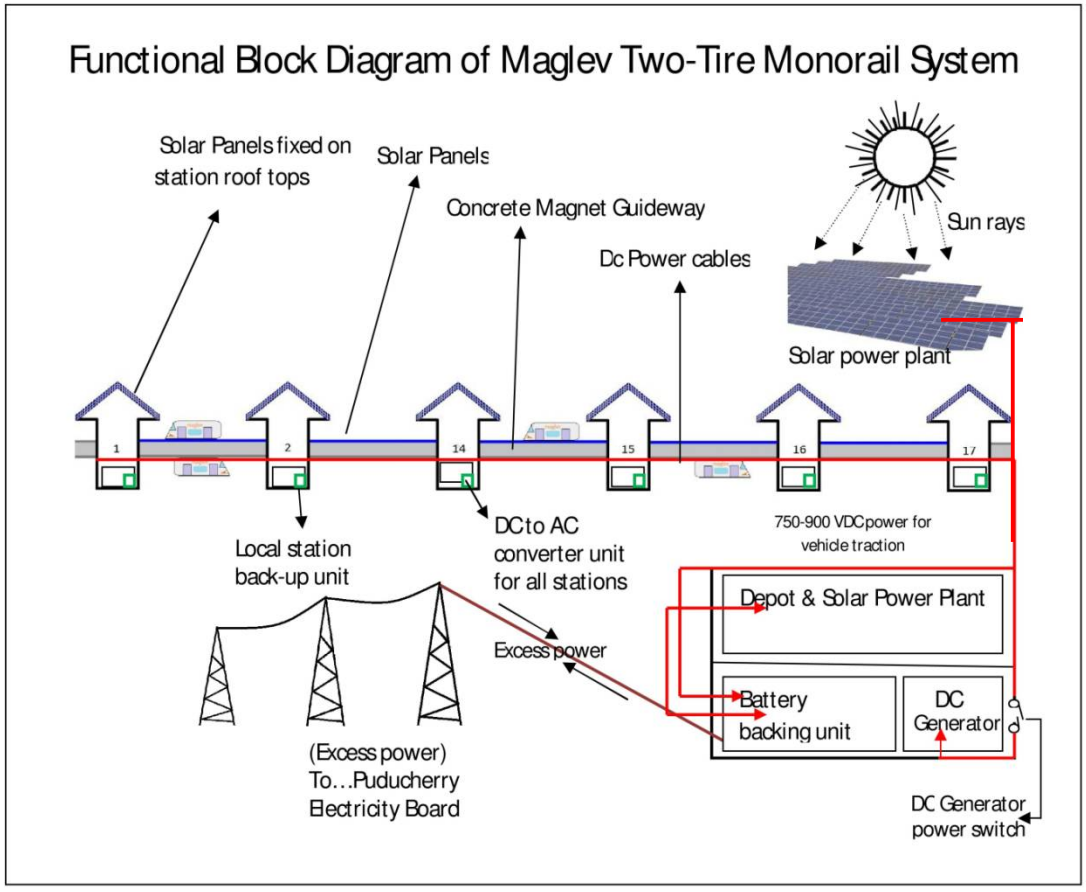
Totally 5 hectares = 12.3553 acreswill be acquired from the puducherry government near the Puducherry University, hardly 500 meters for both setting up the Power plant as well as the vehicle depot.

2 hectares = 4.94211 acres for the depot

3 hectares = 7.41316 acres for setting up the main solar power plant.

Apart from this, some suitable land areas will also be acquired from the Puducherry governemtnt or bought from private property lenders for setting up the station premises Or any other utilities.

9.4- Functional Block diagram of the overall system



9.5- Operational plan

General Approach

Puduvai Trans Route Plan And Station Location Measurement				
No	Station Names	Area Names	Length	Chainage
1	Kurinchi	New Bus Stand	0.00	0.00
2	Malligai	Botanical Garden	935	935
3	Thamarai	Raja Theatre	718	1653
4	Culli	Ajantha Signal	931	2584
5	Vaagai	Bell tower	1010	3594
6	Nanti	Muthailpet	1027	4621
7	Maruthum	Kottakuppam	960	5581
8	Venkai	China Chavady	1102	6683
9	Mullai	Auroville	1073	7756
10	Cemmal	Boomayampalayam	1014	8770
11	Aavarum	Vanur	1036	9806
12	Alli	Pillaichavady	1113	10919
13	Karanthi	Engineering College	1656	12575
	Depot 500 Meters	Depot	500	113075
14	Thilakam	University	1428	14503
15	Arumbu	Kalapet	1282	15785
16	Puduvai	Ganapathichettikulam	1410	17195

Traffic projection

From -To		Rajiv Gandhi Bus stand To Puducherry State Entrance				Puducherry State EntranceTo Rajiv Gandhi Bus Stand			
Rajiv Bus Stand	*Old Bus Stand*	2015	2021	2031	2041	2015	2021	2031	2041
Old Bus Stand	*Raja Theatre*	2085	2481	3325	4469	2380	2844	3825	5144
Raja Theatre	*Ajantha Signal*	3243	3859	5171	6950	2600	3107	4179	5620
Ajantha Signal	*Bell tower*	3928	4674	6263	8417	2965	3543	4765	6409
Bell tower	*Muthialpet*	4559	5425	7269	9769	3740	4469	6010	8083
Muthialpet	*Kottakuppam*	5029	5984	8018	10776	3466	4141	5569	7490
Kottakuppam	*China chavady*	5167	6148	8238	11072	4052	4842	6512	8758
China chavady	*Aurovil M Road*	2127	2531	3391	4557	900	1075	1446	1945
Aurovil M Road	*Bommayapalayam*	5017	5970	7999	10750	4957	5923	7966	10714
Bommayapalayam	*Engineering College*	4769	5675	7604	10219	3834	4581	6161	8286
Engineeri College	*Puduvai University*	3681	4380	5869	7888	2769	3309	4450	5985
Puduvai University	*Ganapathi kulam*	4293	5108	5844	9198	3652	4364	5869	7894
Ganapathi kulam	*Manjakuppam*	5247	6244	8367	11245	3946	4715	6341	8528
Rajiv Bus Stand	*Puduvai*	1280	1523	2040	2742	762	910	1224	1646

Traffic Survey

The above table reflects the data arrived at the actual passenger movement (locals, students, office staffs, labors, tourists and all walks of life across the prescribed places by various modes of transport (buses, cars, two-wheelers…etc.)

Passenger Carrying Capacity

Particular	Length	Width	Height
Leading Car	9.20 m	2.244 m	2.623 m

Passenger Carrying Capacity (@ 6 persons per square meter of standee area) for a single coach train will be approx. in the range of 50 people configuration and seating & standing capacity to be discussed with the car manufacturer during final design.

Traffic Demand

Peak Hour Peak Direction Traffic demands (PHPDT) for the ***Pudhuvai Trans Rapid System Transit*** System for the year 2015, 2021, 2031 and 2041 for the purpose of planning are indicated in Attachment I/A, B, C & D respectively

Train Operation Plan

The following assumptions have been made in the preparation of Train operation Plan:

- Running of services for 17 hours per day (5.30 AM to 11.30) with a station dwell time of 30 seconds.
- Make up time of 5-10% with 8-12% coasting.
- Scheduled speed has been considered as 30 kmph.
- The Capacity can be varied by altering the rake composition or the headway.
- Based on the projected PHPDT demand, train operation has been planned taking the passenger capacity as 50 @ 6 persons per square meter of standee area for the year 2015, 2021, 2031 and 2041.

Year 2015

- 6 min Headway with single coach train.
- Available Peak Hour Peak Direction Capacity of 50 @ 6 persons per square meter of standee area.
- Available Peak Hour Peak Direction Capacity of 60 @ 8 persons per square meter of standee area under dense loading conditions.
- The maximum PHPDT demand of approximately 4800 is in the Section between New Bus Stand and Pucherry University.
- Another PHPDT demand of approximately 5000 is in the Section between Pucherry University and New Bus Stand.
- With this planned PHPDT capacity, optimum utilization of Rolling Stock will be achieved and empty running of trains will be considerably reduced. However, the Rolling Stock is designed

for carrying higher density loading @ approximately 8 standee passengers per square meter and in the sections in which PHPDT capacity exceeds the planned capacity, overloading during these periods will help in reducing the demand for increased deployment of Rolling Stock.

In future, the passengers regarding the PHPDT will be calculated depending upon the population increase in the future.

The PHPDT capacity provided in different years of operation is tabulated below:

Capacity provided for Puducherry Mono Rail Transit System

YEAR	2015	2021	2031	2041
Cars/trains	1	1	1	1
Headway (Minutes)	6.00	4.00	3.00	2.00
Max.PHPDT Demand	8500	10200	12750	25500

Train frequency

The train operation of **Pudhuvai Trans** Mono Rail Corridor provides for the following train frequency:

2015		2021		2031		2041	
Peak hour	lean hour	Peak hour	lean hour	Peak hour	lean hour	Peak hour	lean hour
6.00	10 to 30 min	4.00	8 to 20 Min	3.00	6 to 20 min	2.00	5 to 15 Min

No services are proposed between 00.00 hrs to 5.00 hrs. This period is reserved for maintenance of infrastructure and rolling stock.

Cost Estimate

The estimated cost per coach at March'15 Price level exclusive of taxes and duties may be assumed as INR 8 Crores per Coach. So, total 12 coaches are required in the year 2018 and the budget provision of INR 96 Crores is to be kept in the Estimate for Rolling Stock.

9.6- Car/Vehicle/Rail/Cabin

Body

It is now a standard practice to adopt light weight Aluminium for car body.
Car length = 9 meters.
Car width = 2.2 meters.
Car height = 2.6 meters.

Braking System

There are no wheels or brake shoes involved: An EDS system can provide both levitation and propulsion using an onboard linear motor. EMS systems can only levitate the train using the magnets onboard, not propel it forward. As such, vehicles need some other technology for

propulsion. A linear motor (propulsion coils) mounted in the track is one solution. This linear motor operates to propel the train forward, and when it is necessary to stop the train, the linear motor acts in reverse. I can only guess that this reversing of the linear motor converts the energy of the train into electrical energy which is fed back into the electrical network. The major point is that there is no friction at all and no connetion with the ground, so friction brakes are not possible. As far as I know the train is levitated even when stationary.

Interior and Passageway

Passenger capacity of a car is maximized in a Suspended Monorail System by providing longitudinal seats for seating and utilizing the remaining space for standing passenger. Therefore all the equipments are mounted on the under frame for maximum space utilization. The interior is designed with the comfort and safety of passengers in mind. Hand rails and hand grips are placed within easy reach of all standing passenger. The number and location of the seats are selected to optimize the standing area for passengers.

The unobstructed passageways between cars are designed to give a wider space with easy and faster passenger movement from car to car and it also makes the train to train longitudinal evacuation possible in the event of emergency. Wider vestibules are provided to facilitate easy movement from one car to the other car.

Passenger Carrying Capacity

In order to maximize the passenger carrying capacity, longitudinal seating arrangement shall be adopted. The whole train shall be vestibule to distribute the passenger evenly in all the coaches by providing wider vestibule. Criteria for the calculation of standing passengers are 6 persons per sq m in crush state of peak hour. Depending upon the required passenger carrying capacity and car dimensions of specific supplier, following train composition is recommended: single coach Train:

Passenger Carrying Capacity (@ 6 persons per square meter of standee area) for a single coach train set (Indicative) will be approx 60 seating & standing capacity to be discussed with the car manufacturer during final design. Passenger Carrying Capacity (@ 8 persons per square meter of standee area) for a single coach train set (Indicative) will be & standing capacity to be discussed with the car manufacturer during final design.

Coach Design and Features of Rolling Stock

The body shell will be in Aluminium so as to reduce the tare weight. Coaches will be fully airconditioned with 2 doors on each side and with wide vestibules. Whether coaches will have single or bogie should be left to the manufacturers to achieve the most optimum power consumption, maintenance coasts and maneuverability. Trains will be driverless but provision left for manual operations as well. Specifications in regard to noise levels inside and outside coaches, regeneration during braking, riding index etc are to be specified while inviting bids.

The important criteria for selection of rolling stock are as under:

- Proven equipment with high reliability.
- Passenger safety feature.
- Energy efficiency.
- Light weight equipment and coach body.
- Optimized scheduled speed.
- Aesthetically pleasing Interior and Exterior.
- Low Life cycle cost.
- Flexibility to meet increase in traffic demand.
- Anti-telescopic.

The controlling criteria are reliability, low energy consumption, lightweight and high efficiency leading to lower annualized cost of service. The coach should have high rate of acceleration and deceleration.

Passenger Doors

For swift evacuation of the passenger in short dwell period, two doors of adequate width, on each side of the coach have been considered. These doors shall be of such dimensions and location that all the passenger inside the train are able to evacuate within least possible time without conflicting movement .As the alignment passes through elevated section above ground, automatic door closing mechanism is envisaged from consideration of passenger safety. Electrically controlled door operating mechanism shall be used. The door shall be of Bi- parting pocket sliding Type.

Air–conditioning

With heavy passenger loading of 6 persons/sqm for standee area and doors being closed from consideration of safety and with windows being sealed type to avoid transmission of noise, air conditioning of coaches has been considered essential. Each coach shall be provided with air conditioning units capable of cooling, heating and dehumidifying and thus automatically controlling interior temperature throughout the passenger area at 25°C with 65% RH all the times under varying ambient conditions up to full load. For emergency situations such as power failure or both AC failures etc, ventilation provision supplied from battery will be made. Provision shall be made to shut off the fresh air intake and re-circulate the internal air of the coach, during an emergency condition, such as fire outside the train causing excessive heat and smoke to be drawn in to the coach.

Passenger Evacuation

An emergency walk way in between two track beams at soffit level ensures safe passenger evacuation at any location along the alignment. This walk way will also help for the maintenance staff to reach a stranded train in the event of technical snags. Suitable ladders to be used by passengers for getting down to the emergency walk way will have to be stored in each coach

Communication

The cars are provided with continuous communication with base Operational Control Center and station control for easy monitoring of the individual train in all sections at all the time . Public Address and Passenger Information Display System is provided in the car so that passengers are continuously advised of the next stoppage station, final destination station, interchange station, emergency situations if any, and other messages. The rolling stock is provided with Talk Back Units inside the cars, which permit conversation between passengers and OCC in case of any emergency.

Noise and Vibration

- The trains will pass through heavily populated urban area. The noise and vibration is an important criteria from public acceptance view point. The source of noise are aerodynamics noise generated from equipment like Blower, Compressor, air conditioner, door, Inverter etc.
- Traction motor in running train. The noise due to rubber wheel and beam is expected to be very low. For elimination and reduction of noise following feature are incorporated.
- Provision of skirt throughout the car encapsulating complete under frame.
- Provision of anti drumming floor and noise absorption material.
- Low noising air conditioner.
- Mounting of under frame equipments on anti-vibration pad
- Smooth and gradual control of door.
- Provision of sound absorbing material in the supply duct and return grill of air conditioner.
- Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes. The lower vibration level should be achieved with the provision of suitable secondary suspension.

Passenger Safety Features

CBTC based driverless control

The rolling stock is provided suitable arrangements in accordance with international standards to ensure absolute safety in the train operation. It is an accepted fact that 60-70% of the accidents take place on account of human error. Adoption of driverless eliminates the possibility of human error. However suitable arrangements to be provided for control by a trained personal during contingencies.

Fire

The rolling stock is provided with fire retarding materials having low fire load, low heat release rate, low smoke and toxicity inside the cars. The electric cables used are also normally low smoke zero halogen type which ensures passenger safety in case of fire. Material used in the cars shall conform to fire safety requirement of NFPA 130 and ASTME-119 Standards or the latest edition of other equivalent international standards applicable for Suspended Monorail trains.

Crash worthiness features

Initially the project kicks off with a single car only, if there is going to be additional card included then the rolling stock is provided with inter car couplers having crash worthiness feature which reduces the severity of injury to the passengers in case of accidents.This feature (adding more cars) will be practically implemented depending upon the passenger traffic.

Passageway

The unobstructed passageways between cars are designed to provide adequate space for movement of wheel chair and easy and faster passenger movement from car to car.

Possible Suppliers

Straddled type Suspended Monorails are manufactured by these suppliers worldwide:
Hitachi, Japan, Bombardier, Transportation, Germany, Siemens.Different variants of Suspended Monorails are being manufactured for varied operational demands and specific requirements. However the car dimensions for each manufacturer is fixed and any change would lead to increased cost. Hitachi/Japan is the oldest manufacturer of different types of Suspended Monorails. The cars are with double axle bogie with both the axles as motorized axles.
The car body and under frame is manufactured with Aluminum extrusion with hollow truss to save weight. Car length varies from 9.20meters. Car body is of Aluminum while under frame is of stainless steel.

Future Additions

Since platform lengths are fixed no further addition to the train length is envisaged. Systemcapacity can be increased by reducing the headway. The CBTC system of signaling permitsrunning of trains every 2 minutes which can give a capacity of 15750 PHPDT. This isconsidered enough for Puducherry city for all time to come. The salient features of the proposed Rolling Stock are enclosed as Attachment-I

9.7 The power plant

The power plant is to be set up in 5 hectares., which is equivalent to 12.3553 acres.

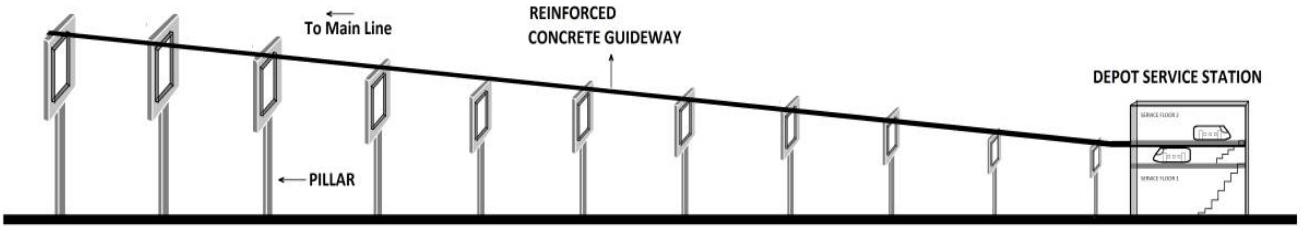
3 hectares equivalent to 7.41316 acres will be allotted for power plant to install the solar panels to generate the necessary 2.5 MW power required for the system.

2 hectares equivalent to 4.94211 acres will be allotted for the depot.
Backup generators and other necessary utilities will fill the area of the power plant.

The 5 hectare area is to be provided by the Puducherry government possibly near around 500 meters away from the Puducherry University, Kalapet.

9.8 The Depot

(i) The Depot is located over a 5 hectare land near Puducherry University about 500 meters from Puducherry University station. The Depot will have facilities for stabling the trains overnight, inspection facilities and workshop facilities. The operation central centre (OCC) is



located in the Car (rail car) depot.

(ii) All inspection lines, workshop lines are designed to accommodate a single car at ground level itself. All inspection works under the rail car will be carried out from the basement level itself, thereby reducing the cost.

(iii) All Stabling lines are designed to accommodate a single rail car each(In future it may be increased depending on the needs). So to accommodate a sinle rail car it will be 9.20 meters. In future if 3 rail cars are joined together then this space will be increased to 30 meters to accommodate the 3 rail cars.

Maintenance features @ The Depot

The main components of the maintenance depot will have:

- Workshop and heavy cleaning shed for the Rolling Stock.
- Operational and functional safety requirements.
- Ancillary buildings for other maintenance facilities.
- Electrical & Mechanical Services, power supply and distribution system.
- Water Supplies, Drainage & Sewerage.

Inspection requirements at depot

Facilities for carrying out inspection activities shall be provided in the inspection bay for following Systems / Equipments of a train:

- Electronics; PA/PIS
- Mechanical components, couplers etc
- Batteries
- Air conditioner
- Brake modules
- Bogie
- Traction Motor
- Vehicle doors, windows and internal fittings
- Power system including converter, circuit breaker etc.
- Current Collector etc.

- These activities shall be grouped into "A" checks and "B" checks. The minor scheduled Inspections ("A" checks) shall be carried out during the day off peak and night. Since "B" checks take longer time, these cannot be completed in the off peak times. For "B" checks, separate line can be nominated where the rakes may be kept for longer time.

Another Inspection line can be used for minor repairs and for adjustment and testing after the IOH and POH.

Design of Depot- cum- Workshop Facilities

Stabling lines at depot:

For the design of the stabling lines in the depot and terminal stations or elsewhere (as may be required), following approximates lengths have been taken in consideration:

Following approximates lengths have been taken in consideration for the design of the stabling lines for a 2-car train:

- Length of one single rake ≈ 9.20 m
- Length of. Car rake = 9.20 m x 2 ≈ 18.40 m
- Gap between two 2- Car rakes = 5m
- Stabling line length for a single car =28m

Space between stabling shall be sufficient to include 1 mt. wide pathway to be constructed between beams to provide access for internal train cleaning and undercarriage inspection with provision of following facilities:

- Each Stabling line to have water connection facility so that local cleaning, if required, is facilitated.
- Platforms at suitable points at each end of stabling lines to enable train operators to board or de- board conveniently.

Inspection Bay at Depot-Cum-Workshop

Length of Inspection Bay

Following approximates length have been taken in consideration for the design of the

Width of the Inspection Bay

The width of the Inspection bay in computed as below:

Roof Inspection platforms and walkways for roof inspection supported on the columns shall be provided. Further, 5m cross pathways are left at each end for movement of material by fork lifter/Leister/Hand trolley. Power supply and Pneumatic supply shall also be made available on each inspection shed columns. Air-circulators shall be provided on each column. The inspection bay shall be provided with EOT crane to facilitate lifting of equipment. Roof and walls shall be of such design that optimum natural air ventilation occurs all the time and sufficient natural light is also available. Each Inspection bay will also have arrangement close by for cleaning of HVAC filter under high pressure water jet.

Workshop Shed

(a) There shall be one bay comprising of two lines each. Size of the workshop bay is proposed to be size of train. The unscheduled lifting and heavy repair line shall be fitted with jack system capable to lift the car unit simultaneously for quick change of bogie, thereby saving down time of Rolling Stock. The arrangement of jack system shall be such that lifting of any coach in train formation for replacement of bogie/equipments is also individually possible. Each workshop bay shall be equipped with two overhead cranes, each spanning the entire length of the workshop bay.

(b) There shall be provided space for repairs of HVAC, Door, and Traction motor etc. repairs. Distinct spaces shall be earmarked for dismantling/repairs/ assembling and testing of each of these equipments. Related machinery for Overhauling / Repairs & testing activities of every equipment are also to be housed in the space earmarked.

(c) There shall be washing and cleaning equipments on the workshop floor. Suitable bogie test stand shall be provided in the workshop. Other heavy machinery shall also be suitably installed on the workshop floor. Air-circulators, lights, Powers supply points and compressed air supply line shall be provided on each workshop column.

(d) There shall be walkways on columns for roof inspections, along the workshop lines. These walkways shall not infringe with cars being lifted/ lowered by means of mobile jacks. Suitable space between the nearest exterior of a car and farthest edge of the walkway has to be ensured to avoid conflict in lifting and lowering of cars.

(e) The small component, bogie painting and battery maintenance cells will be located in the workshop with arrangement that fumes are extracted by suitable exhaust systems.

(f) Workshop will have service building with array of rooms along its length. These can be made by column and beam structure and architecture made of brick works. These shall cater for overhauling sections, offices, costly store item, locker rooms, toilets etc. Two opposite sides widthwise shall be open to facilitate natural air circulation and cross ventilation besides the egress & ingress for coaches. The sidewalls shall also have sufficient width of louvers for providing adequate ventilation.

(g) There shall be space for bogie/ axle repair shop with necessary infrastructure for disassembly, overhead, assembly and testing of mechanical components of bogies/ axle. The repair shop shall be easily approachable from with the workshop for transportation of components.

Following equipment repair/overhaul facilities are planned in the workshop

- Body furnishing
- Bogie
- Traction Motors
- Axle Box and Axle Bearing

- Inverter, High Speed Circuit Breaker
- Battery
- Air Compressor
- Air-conditioner
- Brake Equipment
- Door actuators
- Control and measuring equipments
- Pneumatic/Hydraulic equipment
- Dampers and Springs
- Couplers/Gangways
- Coach Painting

Minimum carriageway width

Minimum carriageway width on the roadway at ground level during the entire period of construction shall be maintained on ground level pillar in the Depot at where the service staff can easily walk and work on the cabins.

Traction Supply Arrangements in Depot

In order to prevent leakage of return current to Depot area, and to ensure uninterrupted power supply to Depot in non revenue hours when power block is availed on the main line, Depot traction supply shall be isolated from main and on-line equipment rooms. Cable route diversification shall be provided. Line supply by providing a separate traction sub-station for Depot area. Tracks of Depot area shall be isolated from main line through insulated rail joints. Remote controlled sectionalizing switches shall be provided to feed power from Depot TSS to mainline and vice versa in case of failure of TSS. Track Earthing Panels (TEP) shall be provided at suitable locations in case the rail potential exceeds the prescribed limit of highest touch potential in Depot, which is 60V as per EN 50122-1. In areas where leaky conditions exist, (eg. washing lines, pit wheel lathe, etc.) insulated rail joints shall be provided with power diodes or equivalent devices to bridge the insulated rail joint to facilitate passage of return current. Stringer type/750V DC current collection system shall be provided in all Depots/workshops. Traction Return Circuit The running rails shall be connected to the common Traction Power System Neutral at each traction sub-station to provide the traction current return path. To limit the extent of conducted EMI, electrical connections with the guideway infrastructure metal reinforcements shall be connected to an Earth drain-wire

Car Delivery Area

There shall be connectivity between the Depot-cum- Workshop and mainline and all trains due for scheduled/ unscheduled works shall reach the depot-cum- Workshop by rail.

However in case of newly procured coaches, which are transported by road, these shall reach the Depot-cum Workshop by the road on trailers. To unload the coaches and bring them to the beam, provision of space, along the side of shunting neck, has to be made for unloading of cars and other heavy materials. This area should be facilitating with the movement of road trawler,

which brings in the cars. There should be enough space available for movement of heavy cranes for lifting of coaches. The unloading area should be easily accessible for heavy duty hydraulic trailers.

Depot Equipment

Emergency vehicles capable of working under ATP shall be provided in Depots for faster and efficient response in the event of breakdown of power supply.

Operational Features

The rake induction and withdrawal to main line will be primarily from the stabling shed. Further, provisions are preferred for direct rake induction and withdrawal to main line from Inspection Shed/workshop area. Movement from depot to the main line shall be planned that the headway of main line is not affected. The stabling lines would be interlocked with the main line thereby induction of train from the stabling would be safe and without loss of time. The proposition for a transfer beam on the incoming line as well as on the outgoing line to facilitate the movement of rake in the depot by Operation Control Centre (OCC) even though the further path inside the depot is not clear shall be explored in the detailed design stage depending on the actual availability of land.

An emergency line is also provided from which an emergency rescue vehicle may be dispatched to main line in the event of emergency if necessary.

Staff Quarters

It is necessary to provide residential accommodation to certain categories of essential and breakdown staff for which a lump sum provision of Rs.20.0 crores has been kept.

Rake Requirement

Based on Train formation and headway as decided above to meet Peak Hour Peak Direction Traffic Demand, Rake requirements has been calculated and tabulated below.

YEAR	2015	2021	2031	2041
Head way(Min)	6 Min	5 Min	4 Min	2 Min
No. of train car	1	1	1	1

Rolling Stock Maintenance Needs

Maintenance Schedule

The following maintenance schedule has been envisaged for conceptual design of depots assuming approx. 2890 per running per train per day, taking in consideration of the passenger load.

Type of Schedule	Interval	Work Content	Locations
Daily	Daily	Check on the train condition and function at every daily service completion.	Stabling Lines

		Interval cleaning/mopping of floor and walls with vacuum cleaner.	
"A" Service Check	5,000 Km (approx. 15 days)	Detailed inspection and testing of sub - systems, under frame, replacement/ topping up of oils & lubricants.	Inspection Bays
"B" Service Check	15,000 Km (approx. 45 days)	Detailed Inspection of 'A' type tasks plus items at multiples of 15,000 Km ('B' type tasks)	Inspection Bays
Intermediate Overhaul (IOH)	420,000 Km, (3and half Years approx.)	Check and testing of all sub-assemblies (Electrical + Mechanical). Overhaul of pneumatic valves, Compressor. Condition based maintenance of sub-systems to bring them to original condition. Replacement of parts and rectification, trial run.	Workshop
Periodical Overhaul (POH)	840,000Km, (7 Years approx.)	Dismantling of all sub-assemblies, rail car, traction motor, gear, control equipment, air-conditioning units etc. Overhauling to bring them to original condition. Checking repair and replacement as necessary. Inspection and trial.	Workshop
Heavy Repairs	-	Changing of heavy item such as cars, traction motor, axles, gear cases & axle boxes etc.	Workshop

The above Schedule may need slight revision based on the actual earned kilometers per train and the specific maintenance requirements of Rolling Stock finally procured.

Washing Needs of Rolling Stock

Cleanliness of the trains is essential. Following schedules are recommended for Indian environment

Rolling Stock requirement in TOP is tabulated below:

S.N.	*Kind Inspection*	*Maint. Cycle*	*Time*	*Maintenance Place*
1.	Outside cleaning (wet washing on automatic washing plant)	3 Days	10 mins.	SinglePass through Automatic
2.	Outside heavy Cleaning (wet washing on automatic washing plant and Front Face, Vestibule/Buffer area.Floor, walls inside/outside of	30 days	2 – 3 hrs.	Automatic washing plant & cleaning & washing shed

Rail car Requirement for puduvai trans rapid transit system

YEAR	2015	2021	2031	2041
Head way (Min)	6.00	5.00	4.00	2
Total No. of cars	12	12	15	30

Following Safety Features Should Be Incorporated In the Design of the Maintenance Depot-Cum-Workshop

- EOT cranes in the inspection bay should be interlocked with 750V dc in such a way that, the cranes become operational only when the Power supply is isolated and grounded.
- Red flasher lights should be installed along the inspection lines at conspicuous location to indicate the DC power supply system is 'Live'.
- TM stacking arrangement should be an inbuilt feature at the end of Workshop Lines.
- Pillars in the inspection bay & workshop should have provision for power sockets.
- Placement of rakes from inspection/workshop lines on to washing lines for interior cleaning on their own power should be possible. Linking DC power supply system its isolation at the cleaning area should be provided. Necessary requirements of safety should be kept in view.
- The roof inspection platform should have open-able doors to facilitate staff to go up the roof for cleaning of roof. Suitable safety interlock should be provided to ensure maintenance staff are enabled to climb on the roof inspection platform only after the DC power supply system is isolated.
- Control Centre, PPIO & store depot must be close to Workshop.
- Width of the doors of the sections wherein repairs of equipments are done should be at least 2 meters wide to allow free passage of equipment through them.
- Provision of water hydrants should be done in workshops & stabling yards also.
- Compressed air points along with water taps should be available in interior of buildings for cleaning.
- Ventilation arrangement inside the inspection shed and workshop should be ensured.

Arrangement for natural cross ventilation from one side to another of inspection & workshop bays to be incorporated along with optimum availability of natural light at floor level.

Plant and Machinery

The Plant and Machinery should be provided suitable for Suspended Monorail trains.

Schedule Of Depot Equipment			
N	Items	Q'ty	
1	Scissor Lift	2	units
2	Scissor Lift	2	units
3	Notebook PC Type Plug-in Diagnostic ATC/TD Testing Equipment	1	set
4	Notebook PC Type Plug-in Diagnostic VVVF Testing Equipment	1	set
5	Notebook PC Type Plug-in Diagnostic Brake ControlTesting Equipment	1	set
6	Stepladder	8	pcs
7	Bogie Drop	1	unit

8	Overhead Traveling Crane	1	unit
9	Car body Support Stand	1	set
10	Tyre Changer	1	unit
11	Hoisting Tool for Running Tyre (Tyre Lifting Jig)	1	set
12	Temporary Bogie	1	set
13	Nitrogen Gas Cylinder Setting Frame	1	set
14	Traverser	1	unit
15	Automatic Car Body Wash Plant	1	unit
16	Overhead Travelling Crane	2	units
17	Car Body Lifting Jib	2	sets
18	Car Body Stand	16	units
19	Bogie Lifting Beam	1	unit
20	Wheel Centre Dismantling Jig	1	unit
21	Axle Bearing Dismantling Jig	1	unit
22	TD Coupling Centering Tool	1	unit
23	TD Coupling Dismantling Jig	1	unit
24	Guide/Stabling Tyre Changer	1	unit
25	Bogie Lifting Jig	1	unit
26	Magnetic Flaw Detector	1	unit
27	Hydraulic Press Brake	1	unit
28	Shrinkage Fitting Device	1	sets
29	Traction Motor Disassembling Jig	1	unit
30	Traction Motor Testing Stand	1	unit
31	Air Brake Testing Stand	1	unit
32	Ultrasonic Cleaning Unit	1	unit
33	Train Vibration Measurement Device	1	set
34	Noise Meter	1	set
35	VVVF Test Bench	1	set
36	Air Compressor Facility	1	unit

Infrastructure Facilities

Stabling Lines in Depot

- A part of the stabling siding in the depot shall be covered with a roof in order to
- facilitate testing of air conditioning of trains and their pre-cooling under controlled condition of temperature.
- Separate toilets adjustment to stabling lines shall be provided with small room for keeping cleaning aids and for utilization by the working staff.

Automatic Coach Washing Plant (AWP)

Provision to be made for Rolling Stock exterior surfaces to be washed using a fully automated Train Washing System, with a throughput capacity of approximately ten trains per hour. The AWP shall be situated at such a convenient point on the incoming route so that incoming trains

can be washed before entry to the depot and undesirable movement/shunting over ingress and egress routes within the depot is avoided. Additional space for plant room for AWP system shall be earmarked.

Train Operators Booking Office

Suitable office facility adjacent to the stabling lines at each depot should be provided so that the train operators reporting 'On' duty or going 'Off' duty can obtain updates regarding 'Special Notices', 'Safety Circulars' and other technical updates/information in vogue. These offices should have an attached a cycle/scooter/car stand facility for convenience of the train operating staff.

Test Beam

A test beam in length duly fenced should be provided beside workshop in the depot. It shall be equipped with signaling equipments. It shall be used for the commissioning of the new trains, their trials and testing of the trains after the IOH and POH. Entry into the test beam shall be planned for a car train. In compliance to safety norms, the boundary of the beam shall be completely fenced to prevent unauthorized trespassing across or along the beam.

Heavy Cleaning Shed

Heavy cleaning shed for cleaning of interior walls, floors, seats, windows glasses etc, outside heavy cleaning, Front/rear Face, Vestibule/ Buffer area, outside walls and roof. A line adjacent to inspection shed should be so provided that placement of rakes is possible from workshop or inspection lines & vice – versa conveniently and with ease.

Power Supply

Auxiliary substations are planned for catering to the power supply requirement of the whole depot and workshop. Details of connected load feeder shall be worked out. Taking diversity factor of 0.5 the maximum demands shall be computed. Two Auxiliary substations are proposed, as the demand by machines in Workshop area would be very large. The standby power supply is proposed through DG set with AMF panel. The capacity of DG set will be adequate to supply all essential loads without over loading.

Compressed Air Supply

Silent type compressor units shall be suitably installed inside the depots at convenient location for the supply of compressed air to workshop and Inspection sheds. Thus, the pneumatic pipeline shall run within the workshop and inspection bays as to have compressed air supply line at all convenient points.

Water Supply, Sewerage and Drainage Works

In house facilities shall be developed for the water supply of each depot. Sewerage, storm water drainage shall be given due care while designing the depots for efficient system functioning. Past records of Municipal Corporation shall be used to design the drainage system. Rainwater harvesting would be given due emphases to charge the underground reserves.

Ancillary Workshop

Arrangement for repairs of Shunters and other ancillary vehicles will be provided. These vehicles will also be housed here itself. Heavy lifting works can be carried out in main workshop. Ancillary workshop will be used for storing parts and their maintenance/ repair for restoration of 750 V dc feed system.

Watch Towers

There shall be provision of adequate number of watchtowers for the vigilance of depot boundary.

Administrative Building

An administrative building close to the main entrance is planned. It can be suitably sized and architecturally designed at the detailed design stage. A time and security office is also provided close to main entrance. It shall be equipped with suitable Access control system for all the staff working in the complex.

Parking Facilities

Ample parking space shall be provided for the two wheelers and four wheelers at the following points.

- Close to the depot entry.
- Close to the stabling lines.
- Close to the Workshop/IBL.
- Space for parking of road and re-railing equipments.

Enough space for parking of road vehicle/ trailers/ trucks etc. Enough space will also have to be earmarked adjacent to workshops. Similarly, provision of space for parking of re-railing equipments will have to be made close to the main exit gate of the Depot.

Shed and Buildings

The shed and buildings should be provided in the depot with their sizes and brief functions suitable for Suspended Monorail trains. At the detailed design stage depending upon the land availability, the decision to locate these buildings can be taken. These can then be architecturally and functionally grouped.

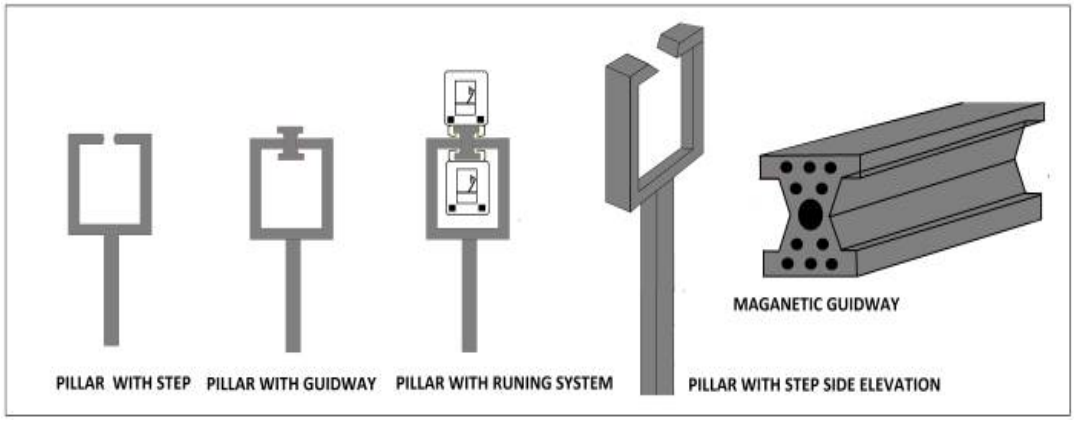
Salient Features Of Rail Rolling Stock For
Puduvai Trans Rapid Transit System

S.	Parameter	Details
1	Traction system	
1.1	Voltage	750 V dc
1.2	Method of current collection	+ve and -ve dc rails
2	Train composition	
2.1	Single Car	Leading Car only

3	Car Body and under frame	Aluminum car body with stainless steel/ corrosion resistance steel under frame
4	Coach Dimensions	
4.1	Width	upto 2.244 m
4.2	Height	upto 2.623 m
4.3	Length	upto 9.20 m
5	Designed - Passenger Loading	
5.1	Design of Propulsion equipment	6 Passenger/ m^2
5.2	Design of Mechanical systems	8 Passenger/ m^2
6	Carrying capacity (Indicative)	
6.1	SNGLE -Car train sets (@ 6 persons per square meter of standee area)	Seating capacity: 35. Standing capacity: 25.
6.2	Single car train (@ 8 persons per square meter of standee area)	Approx. 60 depending upon car configuration and seating & standing capacity to be discussed with the car manufacturer during final design
7	Axle load(T)(@ 8 persons per sqm of standee area)	System should be designed for 12.5T axle load
8	Speed	
8.1	Maximum Design Speed	90 Kmph
8.2	Maximum Operating Speed	80 Kmph
9	Noise Limits (ISO 3381 and 3095 - 2005)	
9.1	Stationary	
9.1.1	Internal (1.4 m above floor, along centre line)	68 dB(A)
9.1.2	External (7.5 m from centre line on the axle centre line height)	67 dB(A)
9.2.1	Internal (1.4 m above floor, along centre line)	72 dB(A)
9.2.2	External (7.5 m from centre line on the axle centre line height)	84 dB(A)
10	Acceleration on level tangent track	1.0 m/sec^2
11	Deceleration on level tangent track	1.2 m/sec^2 (not less than1.3 m/sec^2 during emergency)
13	Secondary Suspension springs	Air
14	Coupler	
15	Detrainment Door	Front / side
16	Type of Doors	Pocket type

17	Passenger Seats	FRP cushioned
18	Inverter & SIV	Self/Forced
19	TM	Self ventilated / suitable cooling
20	Control System	Train based Monitor & Control System (TCMS/TIMS)
21	Traction Motors	3 phase VVVF controlled/ Rotary Permanent Magnet Motor
22	HVAC	Cooling, Heating & Humidifier (As required)
23	PA/PIS including PSSS (CCTV)	Required
24	Passenger Surveillance	Required
25	Battery	Storage Battery
26	Headlight type	LED
27	Maximum gradient	6%
28	Minimum Horizontal Curve Radius	50m
No	The above list is indicative.	

9.9-Pillars



Planning and Design parameters

The design parameters related to the Monorail system described herewith have been worked out based on a detailed evaluation, experience and internationally accepted practices. Various alternatives were considered for most of these parameters but the best-suited ones have been adopted for the System as a whole.

General

The entire stretch of alignment is elevated, carried on single pillars generally located along the median of the road at the New Bus Stand To Puducherry ECR road Entrance of the whole

route no 573 pillars in median of the road.

Concrete Pillars

The columns will be 1" (meter) square concrete with steel pillars erected generally on piled foundations at approximately 15 meter centers generally in the median strips. Based on the geometry of the road at certain locations cantilever piers are found necessary and at some locations the metal guideway track are carried over portals the track beams which are hollow in the centre portion. As a general rule there are few services in these median strips, hence minimal changes to existing infrastructure will be required with the resultant cost and time benefits. The minimum clearance under the track will be 10 meters.

Horizontal Alignment

For the Monorail system with a maximum speed of 50 to 80 kmph, minimum Horizontal curve radius of 30 m is considered desirable with allowable Cant (Ca) = 7.33 % and cant deficiency (Cd) = 5.67 %. However, such radius is not achievable on the proposed corridor. At certain locations, radius of 50 m may also require due to existing road geometric. At such locations reduction in permissible speed will be necessitated.

Horizontal Curves

- Desirable Minimum curve radius in mid-section : 40 m
- Absolute Minimum curve radius in mid-section : 30 m
- Minimum curve radius at stations : 1000 m
- Permissible cant (Ca) : 7.33 %
- Cant deficiency (Cd) : 5.67 %

Transition Curves

- Desirable length of Transitions of Horizontal Curves (Whichever is more) (Ca/Cd in %age) : 6.599 Ca/Cd
- Minimum length of transition curves : 15 m
- Minimum straight length between two Transition Curves : 15 m or NIL
- Minimum curve length between two Transition Curves : 15 m or Nil
- Curve Overlap between transition curves and vertical curves are permitted but will require casting/fabrication of beam to required profile.

However, it may not be possible to provide a transition curve of desirable length due to constraints of circular curve length or otherwise. At such locations the permissible speed may be restricted due to comfort parameter.

Vertical Alignment

Elevated Sections

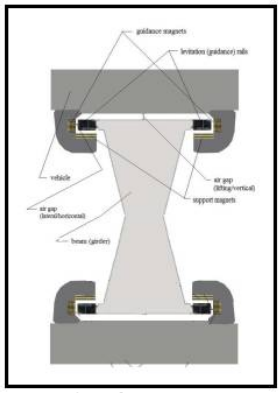
The guideway on Elevated Section should be such that a vertical clearance of

15m above road level is maintained. Actual guideway top level shall depend on type of structure adopted. The reinforced concrete guideway structure will hold the box type pillar.

Vertical Curves
Minimum radius of vertical curves 800m. 1 car length (9m)

Track Centre
Minimum distance from the center of the reinforced concrete guide (track) and the wall of the guideway shall be 1.0 m.

Cantilevered columns
The **Puduvai Trans** guideway or running surface will be suspended by any desired means, such as portals, columns or cantilevered columns, ceilings of building, suspending beams, or girders as is typical suspension methods.



The guideway is the structure that maglev vehicles move over it and are supported and guided by it. Its main roles are: to direct the movement of the vehicle, to support the vehicle load, and to transfer the load to the ground. It is the function of the guideway structure to endure applied loads from the vehicle and transfer them to the foundations. Maglev suspension systems are divided into two groups of Electromagnetic Suspension (EMS) and Electrodynamics Suspension (EDS). There are varieties of vehicles that are manufactured based on these two types of systems. Vehicle path in EMS and EDS systems are called guideway and track, respectively. Basically, there are two main elements in a maglev system including its vehicle and the guideway. The three primary functions in maglev technology are levitation, propulsion, and guidance. Magnetic forces perform all of these. Magnets are used to generate such magnetic forces. For EMS systems, these magnets are located within the vehicle while for EDS systems magnets are located in the track. Performance of EMS system is based on attractive magnetic forces, while EDS system works with repulsive magnetic forces. In EDS system, the vehicle is levitated about 1 to 10 cm above the track using repulsive forces as presented In EMS system, the vehicle is levitated about 1 to 2 cm above the guideway using attractive forces as presented In EMS system, the electromagnets on the vehicle interact with and are attracted to levitation rails on the guideway.

Electromagnets attached to the vehicle are directed up toward the guideway, which levitates the vehicle above the guideway and keeps the vehicle levitated. Control of allowed air gaps between the guideway and vehicle is achieved by using highly advanced control systems. The figure show the components of the guideway and track including levitation and guidance systems in the mentioned maglev systems.

Upon entering a curve at the appropriate speed, centrifugal force can hold the body outwards from the track by 10° in addition to the 10° of super-elevation, so that effectively the body can be swung out to a total 20°. Guideway provides guidance for the movement of the vehicle, to support the vehicle load, and to transfer the load to the ground. In maglev guideways contrary to traditional railroad tracks, there is no need to ballast, sleeper, rail pad and rail fastenings to stabilize the rail gauge. A guideway consists of a beam (girder) and two levitation (guidance) rails.

Guideways can be constructed at grade (ground-level) or elevated including columns with concrete, steel or hybrid beams. Maglev elevated guideways minimize land occupation and prevent collision with other forms of traffic at-grade intersections.

In recent years, with increasing traveling speed of the rail systems, aerodynamic load problems became very important. From the system point of view, aerodynamical topics which affect and define the interface between rolling stock, infrastructure and operation are of paramount importance and the corresponding loads increase with the vehicle speed. If maglev vehicles pass in close proximity to each other or move close to fixed objects such as barriers or buildings, the aerodynamic interactions can produce significant loads on the vehicle or the fixed object. The magnitude and duration of the load depends on the velocity and geometry of the vehicles and also on the ambient wind speed and direction.

Longitudinal force can be applied to the guideway through braking and acceleration of the vehicle, vehicle weight when the guideway has a longitudinal slope, and air pressure(aerodynamics). Since maglev vehicles have no wheels, axles and transmission, they weigh less than a conventional railroad train. The lack of wheels also means that there is no friction between the vehicle and the guideway. These factors result in a reduction in energy consumption. Therefore, the vehicle requires a lesser force for braking and stopping it.
Magnetic levitation is caused by magnetic forces that transmit to guideway by maglev vehicle. In fact, these forces are the consequence of interactions between vehicle and guideway caused by magnets. For EMS systems, these magnets are installed within the vehicle. The forces are of attractive magnetic forces. Lifting magnetic forces due to interaction of guideway and support magnets cause the levitation of the vehicle. Support magnets are located on both sides along the entire length of the vehicle. The attractive force produces inherently unstable vehicle support because the attractive force increases as the vehicle/guideway gap decreases.

Design of Guideway

Guideways are designed and constructed with concrete or steel girders. Concrete guideway girders can be as reinforced or pre-stressed. Guideway girder is evaluated for different loadb cases. As example, the Shanghai guideway girder was evaluated with respect to as many as 14,000 load cases by consideration of the deflection, dynamic strength and thermal expansion.

The most important task or essential aim when designing the alignment is to specify the geometry of the guideway's functional planes so that the passenger traveling in the vehicle on the guideway experiences optimum comfort during the journey. The geometry defines the limit values for accelerations in the three spatial directions (X, Y, and Z direction). However, apart from the acceleration, the consideration of the change in acceleration (jerk) is also an important aspect for comfort. Therefore, various mathematical formulae were discussed for the transition curves and lengths, with the result,

- the horizontal transition curves are designed as sinusoidal curves and,
- the vertical transition curves are designed as clothoids. An exception are the track switching devices which is based on beam theory,

- designed using clothoids for the horizontal transition curves in the turn-out position. The alignment is designed and the space curve established taking into consideration the aspects given above as well as the system characteristics,
- climbing capability up to 10% and cant (super elevation) in curves up to 12%. The space curve data are used in the next design phase as the design criteria for,
- specifying the substructures,
- height of the columns,
- geometry of each individual beam,
- location of the track switching devices and for the precise location of the functional components on the beam.

Safety life-cycle

The risk analysis pertaining to the safety concept for maglev vehicles, which is a key document, is an important criterion in the implementation process for the entire project in accordance with the DIN EN 50 126 life-cycle model, The European railway lifecycle standard DIN EN 50126 defines a process, based on the system life-cycle including RAMS management. It is applicable to modifications of existing systems in operation prior to the creation of the standard, although it is not generally applicable to other aspects of the existing system An OCS may only be approved by the safety authority and accepted by the maglev transport authority if both the generic subsystem and the corresponding application data have successfully passed the safety life-cycle, including.

1. Verification - to determine by analysis and test that the output of each life-cycle phase meets the requirements of the previous phase
2. Validation - to demonstrate by analysis and test that the system meets in all respects its specified requirements
3. Safety assessment.

With a typical spring effect, a restoring force is created, tending to return the body to a neutral position as described with reference again to. This may not be desirable. As a result, embodiments of the present invention provide for a change in lengths of the suspension member without developing restoring forces. The weight of the body is carried below, while presenting equal distribution of loading. This allows the body to swing freely outwards solely under the gravitational and centrifugal forces.

This transverse movement or tilt may be augmented by adding a force to stimulate the tilting motion early as in a tilt train mechanism in the case where curves do not allow a long enough transition segment. The assembly of the car body 20 and the carrying vehicle 72 together allows the center of rotation for the outward swing to be located at the highest point above the center of gravity of the car body, which is most desirable for performance in curves.

Relatively high super elevation is permissible for the system 10. In bottom-supported systems, super elevation usually is limited to 6° by comfort conditions in case a vehicle becomes stationary on a curve. These considerations of comfort in vehicles stationary on curves do not apply to overhead-suspended systems. In case of a suspended vehicle stopping on a curve the suspended

car simply returns to the vertical position. The limit on super-elevation depends upon the friction between the vehicle and the track, such that the downward force of gravity should not cause the vehicle to slip sideways down towards the lower side. The coefficient of friction of steel wheels on steel rails is known to be greater than the selected super-elevation would require. Laboratory experiments using ⅛-scale models were performed by tilting the track with steel-wheel trucks on steel rails to measure the angle of super-elevation when the wheels first slipped across the track. The results measured this angle to be not less than 16.23°. The diagrams and calculations in this submission are based conservatively upon the admissible super-elevation being 10°, approximately 10 inches on standard gauge of 56½ inches.

Operating up to 10° of super-elevation uses only 62% of this range. If at any time the angle of slip might be exceeded, the flanges slide towards the rail and the slip controlled by the flanges of the wheels. Although rail stability must be taken into account, in view of the margins in angles of slip found in this experiment, it is quite reasonable to continue using 10° for planning purposes. Apparently using 10° for super-elevation and for outward swing is quite conservative.

High swinging out of the car body will be permissible. Centrifugal force creates an outward force on the truck and track. The limit is to prevent the wheels from sliding sideways up towards the high side. The value presently adopted is the same: 10° of outward swing in addition to the super-elevation of the track, allowing a total 20° of outward swing, equivalent to a centrifugal force of 0.34 G. The accepted value of outward swing governs the limit of speed and comfort on a curve.

General Formation

- The Site shall be formed to the levels agreed upon with IE.
- The Site shall be surfaced in a manner, compatible with their intended use, and, in particular, footpaths and roadways and connecting facilities shall be clearly defined. Measures shall be taken to ensure that all areas are properly drained and kept free of static water.
- The removal, diversion or reinstatement elsewhere as may be required of any existing works or installation whatsoever within the Site shall be carried out to the satisfaction of the IE.

Roads and Parking

- Space shall be provided within the Site for parking, loading/unloading and maneuvering of motor vehicles.
- Any damage done to the adjoining public roads and fixtures and properties (public or private) shall be made good by the Concessionaire to the satisfaction of the IE.

Drainage and Sewerage

- All storm or rainwater from the Site including any access roads thereto shall be conveyed to the nearest stream course, catch-pit, channel or storm water drain as required. All temporary and permanent works shall be carried out in such a manner that no damage or nuisance are caused by storm water or rain water to the adjacent property.
- No drain or watercourse shall be used without approval.

- Damages or obstructions caused to any watercourse, drain, water- main or other installations within or adjoining the Site shall be made good to the satisfaction of the IE.
- Treatment and disposal of sewage and wastewater from the Works area shall be provided to the satisfaction of the IE.

Buildings

- No permanent structures other than those required for the permanent works shall be permitted on the Site.
- Electricity, water, telephone and sewerage shall be provided by the Concessionaire, as required, for all temporary buildings.
- No potable water from the local authorities shall be used for heating, cooling and humidification purposes, or vehicle washing without the written consent of the authority concerned.

Pedestrian Access

Every existing pedestrian access throughout the Site shall be maintained in a usable condition at all times including lighting, signing and guarding.

Fencing

The Site shall be secured against unauthorized access at all times. In particular fencing or the like shall be maintained, removed and re-erected in the new location wherever and whenever a Works area is relinquished in stages.

Work on Site

The Concessionaire shall nominate a representative whose name and qualifications shall be submitted in writing to the Independent Engineer for review not later than 4 weeks before his appointment and who shall be solely responsible for ensuring the safety of all temporary electrical equipment on Site. The Concessionaire shall not install or operate any temporary Site electrical systems until this representative is appointed and has commenced duties. The name and contact telephone number of the representative having been reviewed by the IE shall be displayed at the main distribution board for the temporary electrical supply so that he can be contacted in case of an emergency. Schematic diagrams and the details of the equipment for all temporary electrical installations shall be submitted by the Concessionaire, and these diagrams together with the temporary electrical equipment shall be submitted to the IE for his review.

All electrical installation work on Site shall be carried out in accordance with the requirements laid down in BS 7375. All works shall be supervised or executed by qualified and suitably categorized electricians, who are registered as such under the Electricity Ordinance 1990/Electricity (Registration) Regulations 1990.

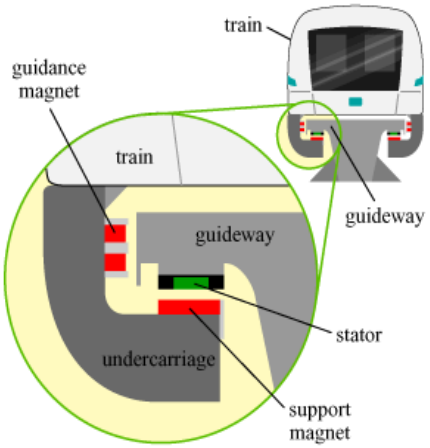
Main pillar measurement

Rolling Stock Cost

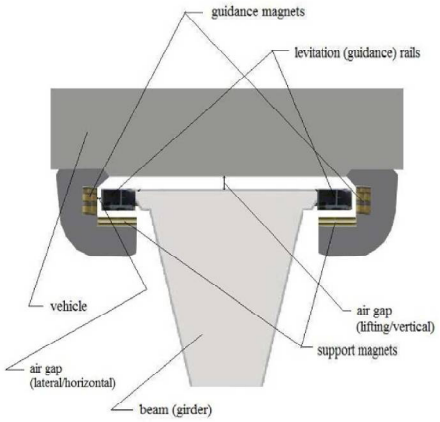
The estimated cost per coach at March'15 Price level exclusive of taxes and duties may be assumed as INR 8 Crores per Coach. With single car train sets, total 10 coaches are required in the year 2018 and the budget provision of INR 96 Crores is to be kept in the Estimate for Rolling Stock. This rate has been considered excluding the taxes.

Performance of EMS system is based on attractive magnetic forces. While EDS system works with repulsive magnetic forces. In EDS system, the vehicle is levitated about 1 to 10 cm above the track using repulsive forces.

In EMS system, the vehicle is levitated about 1 to 2 cm above the guideway using attractive forces as shown in the figure.

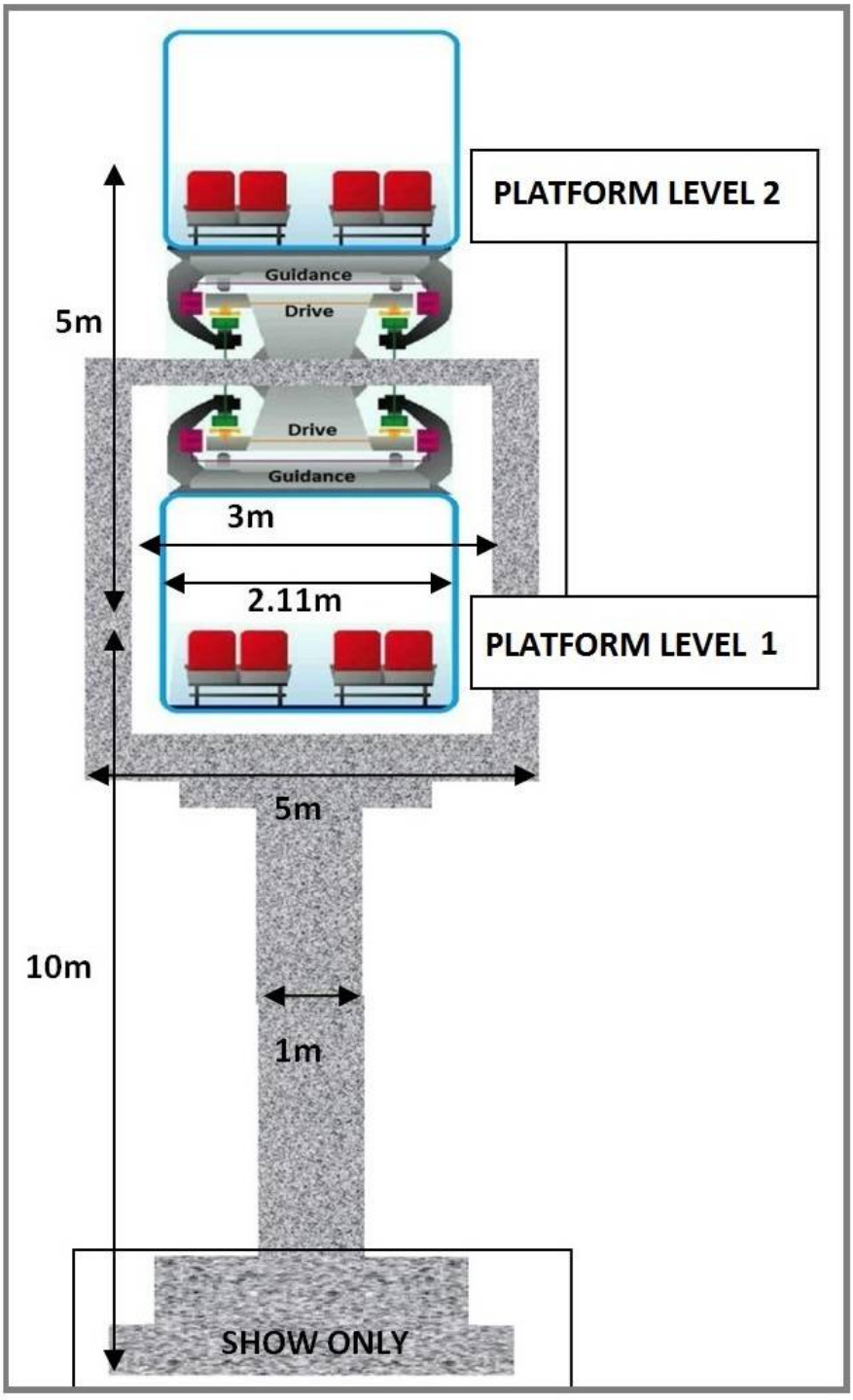


The electromagnet, initially when the train is started will in all probability not be perfectly lined up, so there will be a net force downwards. Also, if the train has some velocity, the train will have enough inertia to move to this point where it will feel the net force downwards, and will thus continue to move even faster downwards. Furthermore, the train will be in the magnetic field - which is the field due to the set of permanent magnets directly below the first set and the fields are pointing in the same direction, so there is an attractive force downwards (and by the same symmetry arguments used above, the train is also accelerated downwards by this set of forces as well).



When the train moves to the next set of magnets – the ones that it is attracted to – there will be an attractive force that resists motion. However, a sensor in the circuit senses the change in magnetic field, which sends a signal that causes the current to reverse. Thus the magnetic field of the electromagnet is in the opposite direction, the attractive force becomes a repulsive force, and the propulsion cycle continues.

To create levitation, a magnetic repulsion force is used to counteract the force of gravity. The right magnetic material must be used to achieve levitation. Magnetic materials are classified into three categories: paramagnetic, diamagnetic, and ferromagnetic. Among the three diamagnetic is the best option to go with since it repels the permanent magnet placed near it.



Schematic diagram of a pillar

9.10-The Guideway

The guideway is the structure that Maglev Magnetic Two-tier Monorail vehicles move over it and are supported and guided by it. Its main roles are: to direct the movement of the vehicle, to support the vehicle load, and to transfer the load to the ground. It is the function of the guideway structure to endure applied loads from the vehicle and transfer them to the foundations. It is the main element in Maglev Magnetic Two-tier Monorail system and holds big share of costs for the system. It is vital for Maglev Magnetic Two-tier Monorail trains. The cost of the guideway structure is expected to be 60-80 percent of the overall initial capital investment cost Maglev Magnetic Two-tier Monorail train levitates over single or double track guideway. Guideway can be mounted either at-grade or elevated on columns and consists of individual steel or concrete beams. Elevated guideways occupy the least amount of land on the ground. Moreover, with such systems there is guarantee of meeting no obstacle while along the route. To guarantee safety for Maglev Magnetic Two-tier Monorail trains necessitates guarantee that there will be no intersection between guideway and other forms of traffic routes. To serve the purpose, general proposition is to have elevated guideways.

Guideway provides guidance for the movement of the vehicle, to support the vehicle load, and to transfer the load to the ground. In Maglev Magnetic Two-tier Monorail guideways contrary to traditional railroad tracks, there is no need to ballast, sleeper, rail pad and rail fastenings to stabilize the rail gauge. A guideway consists of a beam (girder) and two levitation (guidance) rails. Guideways can be constructed at grade (ground-level) or elevated including columns with concrete, steel or hybrid beams. Maglev Magnetic Two-tier Monorail elevated guideways minimize land occupation and prevent collision with other forms of traffic at-grade intersections. Guideways are designed and constructed as single or double tracks. Guideways can be U-shaped, I-shaped, T-shaped, Box, Truss and etc.

Guideway design

Guideways are designed and constructed with concrete or steel girders. Concrete guideway girders can be as reinforced or prestressed. Guideway girder is evaluated for different load cases.

Guideways are usually made as single-span or two-span elevated or at-grade. But for larger spans the use of continuous two span supports is recommended. This can reduce deflection and the effect of temperature variations (FTA, 2004). Guideways are modeled as a single or multi span beam with uniformly distributed dead and live loads.

Guideway Construction

The System IS concrete metal guide which are made on they are manufactured using steel plates and a continuous welding machine and will be fabricated in a specially built factory in a suitable location at the start of the first line. After fabrication, they will be transported along the newly constructed System guide for erection. This will significantly reduce construction costs and disruption to traffic. At the site, they will be erected using bridge construction techniques. This process will be enhanced by the adoption the “CIM Steel” system (Computer Integrated Manufacturing) that has been recently developed and adopted in Europe. In this process, the

geometry of the steel is developed and then structurally analyses in the engineering office. The final design data is then transmitted electronically directly to the fabrication shop for fast, computerized, "just in time" manufacture and immediate delivery to the site. This process will give significant time and cost benefits.

Elevated Guideway Structure – Design Criteria

This outline design criteria provide minimum standards which are to govern the design of the permanent works and shall be read in conjunction with other contract documents.

Guideway Structure: General Design Guidelines

- The carrying magnetic concrete guideway structure should be designed for Load configuration based on Coach Design and Train configuration. Other loads and forces to be considered for design should be in accordance with the technical characteristics of the Rolling Stock.
- The Indian Railway's Concrete Bridge Code shall be followed for design for RCC sub-structure and foundations and for pre stressed concrete girders with internal pre stressing. For superstructure with external pre stressing, International Standards shall be followed.
- The reinforced concrete guideway beams structure shall be supported and on single columns erected mostly along median of the road. At few locations it may be necessary to adopt portal frame support in lieu of single column.
- Detailed topographic and geo-technical investigations along the corridor shall be carried out by the Concessionaire.
- The minimum clearance above the road level shall be 5.5 m. In case of minor roads/streets lower clearance may be adopted with specific approval of the agency or authority owning and / or maintaining the road/street.
- Ducts for laying electrical signal and communication cables shall be provided on either side.
- Adequate drainage shall be provided for the guideway structure and connected suitably to the underground drainage.
- The pre-fabricated, conventional, reinforced concrete box beams, with their attached aluminum-loop panels, is mass produced at low cost at a factory. The beams are then shipped from the factory, by truck or rail, to the Maglev construction site, along with the prefabricated piers. The only field construction required is the small poured concrete footings for the piers. Cranes lift the beams and piers into place, allowing a complete guideway route to be erected in a few weeks. The beams and piers can also be transported along finished portions of the guideway to the erection site, eliminating the need for road or rail transport. For construction of the guideway structure, use of prefabricated elements to the maximum possible extent shall be adopted in view of the need for fast track work and the corridor being heavily congested.
- The structure should be aesthetically pleasant.
- Approach slabs shall be provided between viaduct and at grade section.

Codes and Standards

The following codes shall be applicable:
IRS; IRC; IS; AASHTO; and BS.

Indian Railway Standards (IRS).
IRS – Bridge Rules for loading (Min. of Railways).
IRS – Code of practice for steel bridges.
IRS – Code of practice for plain, reinforced and pre-stressed concrete for general Bridge construction, latest revision.
IRS – Code of practice for the design of substructures and foundation of bridges.
IRC-18 – Design Criteria for Pre-stressed Concrete Road Bridges (Post Tensioned Concrete).
IRC-21 – Standard Specification and Code of Practice for Road Bridges, Section III – Cement Concrete (Plain and Reinforced).
IRC-22 – Composite Construction for Road Bridges .
IRC-78 – Foundation and Substructure.
IRC-83 (Part-I) – Metallic Bearings.
IRC-83 (Part-II) – Elastomeric Bearings.
IRC-83 (Part-III) – POT cum PTFE Bearings.
IRC-SP –47 Guidelines on Quality Systems for Road Bridges (Plain, Reinforced, Pre-stressed and Composite concrete).

Reference codes and standards

The following codes and standards shall be adopted:

- National Building Code.
- Bureau of Indian Standards (BIS).
- National Fire Protection Association.
- ASTM Standards in Building Codes.
- International Standards Organization (ISO).
- American Society of Civil Engineers (ASCE).

American National Standards Institute (ANSI).

Loading

The most important part in the analysis and design of guideway is structural loading. The loading of the Maglev Magnetic Two-tier Monorail vehicle is an important parameter in the practical application. It is related to the magnetic forces. The guideway must carry a dead load due to its own weight, and live loads including the vehicle loads. To incorporate the dynamic interaction between the guideway and the vehicle, the live load is multiplied by a dynamic amplification factor. Lateral and longitudinal loads including wind and earthquake loads may also need to be considered. The guideway loadings are modeled as dynamic and uniformly distributed magnetic forces to account for the dynamic coupling between the vehicle and the guideway. Magnetic forces are generated by the Maglev Magnetic Two-tier Monorail vehicle and cause structural loading that transmits to the guideway. This can happen whilst such a vehicle is stationary or in motion. In order to prevent contact between the vehicle and the guideway and maintain the required gap between them, the system is continuously under Operation Control System (OCS) command.

Some decisive factors for the design of Maglev Magnetic Two-tier Monorail guideways are listed as being constructible, durable, adaptable, reliable, readily maintained, being slim in accordance with urban environment and being light to be constructed more efficiently (Jin et al., 2007. In this regard, one of the main challenges to guideway designers is to produce a structure that will be easily maintainable to the narrow tolerances and precise alignment required for practical Maglev Magnetic Two-tier Monorail operation, to achieve a structure which is economically and financially justifiable and attractive. Besides satisfying the above conditions, important parameters in the design of guideway include vertical live loads and its pursuant dynamic amplification factors (DAF), plus deflection due to this load. These parameters constantly govern the design process, and they play a major determining role in the structural optimization of the guideway girder systems. Vehicle/guideway interaction of the Maglev Magnetic Two-tier Monorail system is an important and complicated problem. It is influenced by the levitation system, guideway structure, vehicle mechanical structure, running speed, etc. So the investigation of it should be launched out in many aspects. Among the various parameters which affect on design of Maglev Magnetic Two-tier Monorail guideway, dead and live loads, dynamic amplification factor and deflection have major importance. Assessment of deflections due to the vertical loads for guideway beam during operation of Maglev Magnetic Two-tier Monorail vehicle is very important. It is the most influential parameter in design of guideway.

While there are routine processes for the calculation of the guideway dead loading, there is a need for special treatment in the calculation of its live loads. Live load intensity and its distribution patterns are highly dependent on the structural behavior. According to AREMA (American Railway Engineering and Maintenance-of-Way Association) and UIC (International Union of Railways) regulations live load models for conventional railway track are based on a combination of concentrated and distributed loads. This is compatible with the use of wheels and the behavior of locomotives in conventional trains. In the case of trains with magnetic levitation with no wheels and added complexity of lifting magnetic forces due to support magnets, the analysis is much more complicated.

Lifting magnetic forces (vertical loads)

Vertical loads imposed on Maglev Magnetic Two-tier Monorail guideway can be categorized as dead loads due to the weight of the guideway divided by the length of the span, and live loads due to the interaction between guideway and the vehicle. Dynamic magnetic lifting forces are the forces generated while the vehicle moves. The interaction force (total dynamic lifting magnetic force of each car body) between each car body and the guideway, is the sum of the interaction forces (dynamic lifting magnetic forces) between the nth bogie in each car body and the guideway. Also, considering the fact that each guideway consists of two levitation rails, the interaction force between the nth bogie in each car body and each of the levitation rails, is equal to one-half of the interaction force between the nth bogie in each car body and the guideway. Interaction force between each bogie in each car body and the guideway is a uniformly distributed live load. Load uniformity comes from the absence of the wheels and presence of lifting magnetic forces with uniform intensity that is generated by support magnets. Interaction force between each bogie in each car body and each of the levitation rails is also uniformly distributed. If bogie lengths in each car body are the same, as normally is the case, then the total

interaction force intensity between each car body and the guideway is equal to the interaction force intensity between the nth bogie in each car body and the guideway over the length of bogie. Also, in such case, the total interaction force intensity between each car body and each of the levitation rails over the length of each car body is equal to the interaction force intensity between the n-th bogie in each car body and each of the levitation rails over the length of each bogie. Each Maglev Magnetic Two-tier Monorail vehicle involves some (one to n…) no of car bodies with different lengths. Hence, maximum interaction force intensity between car bodies and the guideway can be considered as Maglev Magnetic Two-tier Monorail live load. In general, Maglev Magnetic Two-tier Monorail live loading is evenly and uniformly distributed. The amount of Maglev Magnetic Two-tier Monorail live load is generally less than the dead load of its guideway. Also, the uniformly distributed live load of Maglev Magnetic Two-tier Monorail applied to each levitation rail over the length of live loading.

Lateral magnetic forces (lateral loads)

In the static case, lateral (guidance) magnetic forces do not exist. However, during vehicle movements and while it moves to the sides, interaction of guidance magnets and levitation rails brings the vehicle back to its central stable position. This causes lateral magnetic forces.
These lateral forces act in lateral and normal directions to the levitation rails and transmit to the guideway. When the vehicle deviates to the right, guidance magnets on the right side of horseshoe shaped section of the vehicle and levitation rail on the right side of guideway attract each other while guidance magnets on the left side of horseshoe shaped section of the vehicle and levitation rail on the left side of guideway repulse each other. This brings the vehicle back to its stable position. At the location of interaction between guidance magnets and levitation rails, forces in the left and right zones are of the same size and act on the same direction to the guideway.

One of the main advantages of the elevated transportation systems such as Maglev Magnetic Two-tier Monorail is the high resistance of their tracks in dealing with the earthquake forces.
Irregular earth movements generate such forces that can be capable of damaging the manmade structures. The size of such forces depends on the nature of the earthquake, the natural period for the bridge structural vibrations and the natural period for vibrations of the soil under the foundation. For the design of the exceptional bridges with very large spans or for the bridges that are near the earth's fault lines, calculations for the earthquake forces depend on some detailed studies. One may use the static analysis for the design of small to medium size bridges. Dynamic bridge analysis however, needs huge number of calculations that are economically formidable and sometimes turn to be impossible. On the other hand, the quasi static approach uses a load (or an impact) factor that converts the dynamic loads into the static loads. Therefore, such method assumes static equilibrium when determining the structural behavior. The load (or the impact factor) comes from the experiences, engineering judgment and from mathematical models. Generally, the wind effect depends on the geographical position of the district, its altitude from the sea level, the local topography and to some geometrical characteristics. For the guideway static calculations, regardless from the number of the tracks the wind force affects only one Maglev Magnetic Two-tier Monorail vehicle.

The interaction force (dynamic lateral magnetic force) between the n th bogie in each car body and each of the levitation rails is defined by the summation of the interaction forces (dynamic lifting magnetic force) between the n th bogie in each car body and each of the levitation rails and the wind or the earthquake lateral force, whichever that turns to be bigger.
Lateral forces on the Maglev Magnetic Two-tier Monorail guideway can be caused by the vehicle sliding, particularly on curves. Lateral guidance is provided by guidance magnets. The dynamic lateral magnetic force imposed on the guideway can be considered as a uniformly distributed load. Centrifugal forces, in equal speed and curve radius, are less in Maglev Magnetic Two-tier Monorail due to lower weight of the vehicle than in rail tracks.

Longitudinal loads

In recent years, with increasing traveling speed of the rail systems, aerodynamic load problems became very important. From the system point of view, aerodynamical topics which affect and define the interface between rolling stock, infrastructure and operation are of paramount importance and the corresponding loads increase with the vehicle speed. If Maglev Magnetic Two-tier Monorail vehicles pass in close proximity to each other or move close to fixed objects such as barriers or buildings, the aerodynamic interactions can produce significant loads on the vehicle or the fixed object. The magnitude and duration of the load depends on the velocity and geometry of the vehicles and also on the ambient wind speed and direction. For high speed railroads several studies have examined the loads produced by passing trains and their potential for causing an accident. The results of these studies show an important pressure load acting on the object which can have serious consequences.

i) Although the safety aspect does not concern the maglev vehicle as strongly as it concerns conventional railroads, because Maglev Magnetic Two-tier Monorail is guided by magnets on both sides and cannot derail, many aspects are similar. In both cases, the interaction of vehicles and infrastructure implies aerodynamic system issues, e.g. that of train induced aerodynamic loads leading to structural vibrations and a decrease of ride comfort. The pressure load caused by passing Maglev Magnetic Two-tier Monorail vehicles has an important aerodynamic effect on the sidewall motion and therefore on the ride comfort. While two vehicles are passing each other at high relative speed, the quasi-static pressure distribution along each vehicle presents a dynamic load on the other vehicle. The dynamic pressure load strongly depends on the velocity of the vehicle, the geometry of the bow-part of the vehicle and the distance between the guideway. The time behavior is given by the relative velocity between the two vehicles. The mechanical load on the car body depends mainly on

- the amplitude of the pressure wave,
- the velocity of the oncoming vehicle,
- the bow-shape of the oncoming vehicle, and
- the distance between the two tracks.

ii) The relation between the propagation speed of the structural Eigenmode with the corresponding wavelength and the relative velocity between the two vehicles

iii) the load at a specific point of the structure depends on its location within the car body, but not on the overall length of the vehicles or the position of the carriage body within the vehicle set.

In general, the aerodynamic forces play an important role in affecting the interaction response of Maglev Magnetic Two-tier Monorail-vehicle/guideway system due to their velocity-dependent characteristics, especially at more higher speeds found in HSR systems around the world. Longitudinal force can be applied to the guideway through braking and acceleration of the vehicle, vehicle weight when the guideway has a longitudinal slope, and air pressure (aerodynamics). Since Maglev Magnetic Two-tier Monorail vehicles have no wheels, axles and transmission, they weigh less than a conventional railroad train. The lack of wheels also means that there is no friction between the vehicle and the guideway. These factors result in a reduction in energy consumption. Therefore, the vehicle requires a lesser force for braking and stopping it.

Analysis

During the past four decades, research and development have been performed in the areas of magnetic levitation, interaction of vehicle with guideway, and optimization of vehicle suspensions. The results of these efforts are useful in providing appropriate criteria for the design of Maglev Magnetic Two-tier Monorail systems. The dynamic response of magnetically levitated vehicles is important because of safety, ride quality and system cost.

Esclaters

Platforms will be elevated, allowing direct access through train doors without steps or ramps. No free passenger access to the guideway will be permitted, for safety reasons. This is mandatory due to the speed and low noise profile of Maglev Magnetic Two-tier Monorail systems. The use of docks and in-station transfer switches means that passing trains, while not necessarily in close proximity to platforms, could injure anyone who strayed into the active main guideway. For vertical circulation all Maglev Magnetic Two-tier Monorail system stations will provide escalators and elevators as the primary elements and stairs as the backup.

The station services, including public rest rooms, snack service, newsstand, staffed ticketing and information center, and public telephones should be provided. Stations should also provide facilities (shops, changing rooms, luggage storage, etc.), access to traveler services such as station cars, and advertising displays. All stations would feature public art appropriate to their locations. Public art is an excellent adjunct to station design and a popular feature. Train and station operations require the station personnel and security. Station managers and ticket agents control the station activities, providing passenger assistance and information as well as inspecting train sets when in station. Armed security personnel are provided at every station. Large stations have multiple security personnel, and parking garages are policed.

Operation Performance

The most important task or essential aim when designing the alignment is to specify the geometry of the guideway's functional planes so that the passenger traveling in the vehicle on the guideway experiences optimum comfort during the journey. The geometry defines the limit values for accelerations in the three spatial directions (X, Y, and Z direction).
However, apart from the acceleration, the consideration of the change in acceleration (jerk) is also an important aspect for comfort. Therefore, various mathematical formulae were discussed for the transition curves and lengths, with the result,

- the horizontal transition curves are designed as sinusoidal curves and
- the vertical transition curves are designed as clothoids.

An exception are the track switching devices which, based on beam theory, are also designed using clothoids for the horizontal transition curves in the turn-out position. The alignment is designed and the space curve established taking into consideration the aspects given above as well as the system characteristics, e.g.

- climbing capability up to 10% and
- can't (super elevation) in curves up to 12%.

The space curve data are used in the next design phase as the design criteria for

- specifying the substructures,
- height of the columns,
- geometry of each individual beam,
- location of the track switching devices and for the
- precise location of the functional components on the beam.

The reductions in speed in the track course result from slopes, where the residual acceleration abilities do not maintain a high speed. The primary energy demand that is relevant for the comparison between different means of transport averages under the examination of the current power mix as 2.5 times the secondary needs.

Optimal design speed

The optimal design speed of transportation project relates not only to the national integrated transportation system structure, but also to the energy consumption structure of national economy and the traveling quality of passengers. Starting from the analysis to technical and economical characteristics of the Maglev Magnetic Two-tier Monorail system, this paper tries to find the optimal design speed of Maglev Magnetic Two-tier Monorail transportation system in different aspects such as the speed structure of integrated transportation system and the project benefit. As a result, it gives reference to the planning of Maglev Magnetic Two-tier Monorail transportation project.The determination of the design speed is a strategic decision-making for a transportation model. It relates to the compatibility with social economic development. The design speed of a transportation model has remarkable influence on its construction and operation cost, the ability of its competition in transportation system.

The maximum operating speed the train may be raised step by step along with the market demand and the technical development. Therefore, the optimal design speed of mobile equipment of a project should be considered according to the conditions in the near and far future.

9.11-About Puducherry

The Union Territory of Puducherry was constituted out of the four erstwhile French establishments of Pondicherry, Karaikal, Mahe and Yanam. Puducherry and Karaikal are embedded with Tamil Nadu.

The bulk of Puducherry region is an irregular stretch of land consisting, the municipalities of Puducherry & Oulgaret and commune panchayats of Ariankuppam, Villianur, Nettapakkam, Mannadipet and Bahour. The total area of Puducherry region and its eleven enclaves is 290 Sq. km, with the total population at 735,332 according to the 2001 census.

Besides the main area, the region's eleven enclave's lie scattered within Villupuram, Tindivanam and Cuddalore Taluks. The three isolated enclaves of Mannadipet Commune lie on the North West. One peculiar feature of Mannadipet Commune is that the area surrounding Vadhanur village in Mannadipet main enclave is a mixed territory. Some of the plots in the area belong to Puducherry and the others to Tamilnadu. Nettappakkam Commune has one isolated enclave towards the southeast. Villianur has a very small enclave, viz., and the Manakuppam enclave close to the limits of Nettappakkam Commune forming part of the bulk.

Thus from north to south these eleven enclaves skirt the main entity of Puducherry almost in a semi-circle between 110 45' and 120 0' northern latitude and between 790 37' and 790 50' of eastern longitude. The Bay of Bengal bound the region as a whole on the east and by Villupuram & Cuddalore District on all the other sides.

The project area comprises of Puducherry municipality, Oulgaret municipality, Ariankuppam commune panchayat and Villianur commune panchayat. The total project area is spread over 71.9 Sq.km. B. History and Growth Characteristics

Puducherry called as 'Poduke' in olden days has a very old history that dates back to first century AD. According to on legend Puducherry was once was an abode of scholars well versed in the vedas and hence called Vedapuri. During the 14th Century, Puducherry was under Vijayanagar Empire and was ruled by Naiks of Thanjavur and Bijapur Sultan. During this period Portuguese and Danish merchants used the place as a trading center. The French first established their 'loge' in Puducherry in 1674. In 1693, it was captured by the Dutch but restored in 1699 following the Treaty of Ryswick. The territory thus restored to the French, included Puducherry Fort and its

surroundings which were taken possession by the French after paying the Dutch a sum of 16,000 pagodas which they asserted as having spent for acquiring the areas adjacent to the town.

In 1703, Francois Martin obtained the village of Kalapet from Nawab Dawood khan, the representative of Aurangzeb, in order to obtain timber from the forests surrounding it for construction of houses in Puducherry town. The same Nawab ceded the village group of Ozhukarai in 1706, as well as the village groups of Murungappakkam, Olandai, Pakkamudiyanpet and Karuvadikkuppam. Nawab Safdar Ali gave the villages of Theduvantham and Archivak (Abhishekapakkam), Odiyambattu and Tirukkanji as gift to Dumas in September 1740.
In 1750 following the victory of Ambur, Musafar Jung confirmed the grant of Villianur and added 36 villages of Bahur so that the advance posts were brought up to the Ponnaiyar. Since then, the French territories were besieged four times second in 1761, resulted in the capture of the town. Following the Treaty of Paris signed on 10 February 1763; Puducherry and its dependencies which included Ozhukarai, Ariankuppam, Virampattinam, Murungappakkam, Pakkamudiyanpet, Olandai, Abhishekapakkam, Kommapakkam and Kalapet were restored to the French. It was again besieged and captured in 1778 and restored in 1785. It was captured a third time in 1793. Following the Treaty of Peace of 30th May 1814 the establishments were finally restored in 1816. The Treaty of 1814 provided for the restitution of all the settlements and factories which France had possessed in India as on 1 January 1792. These possessions were determined by the Convention concluded at Versailles on 31st August 1787 and by the Treaties of Peace (Versailles) signed on 3 September 1783 and previously on 10 February 1763. Thus by the Treaty of 1814, the French were allowed to retain only those areas which were in their possession in 1763. Since then these establishments continued under French rule for one hundred and thirty eight years, after which the French left the shores on 31st October 1954, following transfer of power.

Physical and Geographical Characteristics

Physical Characteristics. Puducherry region is a flat country of average elevation of about 15 metres above sea-level, intersected by the deltaic channels of River Gingee, Ponnaiyar and other streams forming the two main drainage basins, interspersed with lagoons, lakes and tanks. River Gingee crosses the region diagonally from northwest to southeast. Ponnaiyar forms the southern border. The alluvial delta of Ponnaiyar is only a few metres above the sea. To the northwest of these hills are a section of fossiliferous limestone formations of the Cretacian age. To the south of this area is situated the alluvial tract of Varahanadi (Gingee) and to the north is the recent alluvium. Geographical Zones. Puducherry region consists of four geographical zones.
The coastal zone comprising newer and older dunes including saline areas of clayey texture. The second zone is made up of the two plateaus called the Puducherry plateau and the Tiruvakkarai plateau composed of a geological formation called the 'Cuddalore Sandstone'. The upper layers are made up of red transported ferralitic soil. The Valudavur plain lies between these two plateaus. Marshy depressions are also frequently encountered in the plains of Valudavur. The flat alluvial zone occupies the rest of the Puducherry region.

Climate

Puducherry experiences a hot and tropical maritime type of climate characterized by small daily range of temperature, humid weather and moderate rainfall. The summer season prevails from

March to June followed by the period of the southwest monsoon, which lasts up to September. The months of October and November constitute the main northeast monsoon season. The winter season prevails from December to February.

Rainfall

The average annual rainfall is of the order of 127cm. Of this about 50 per cent is recorded during October – November. November is the rainiest month contributing about 30 per cent of the annual rainfall. The variability of annual rainfall is fairly large and that of seasonal rainfall still larger. In a year there are on an average, about 55 rainy days

Temperatures

The mean daily temperature ranges from 250C to 320C and will rise to 370C during hot summer months of May and the early parts of June. December and January form the coolest part of the year with the mean daily maximum temperature at about 280C and the mean daily minimum temperature at about 210C.

Humidity

In view of the coastal location the relative humidity is generally high. It ranges from 50 percent to 75 percent.

Wind Directions

Winds are generally light to moderate in velocity during summer and early southwest monsoon season. During southwest monsoon, winds are mostly from south to west. During the summer season, winds are southwesterly or westerly in the morning and southerly or southwesterly in the afternoons. In October and January winds are varied in directions.

Ground Water

Ground water in the project area is generally found at the shallow depths of five to ten feet in the coastal areas and 30-40 m in the western parts. The ground water drops by few meters in the lean months.

Linkages and Connectivity

Puducherry Town is situated on the eastern side of Puducherry
district and is the district headquarter town. The town has first-class connectivity with Tamil Nadu state. The East Coast Road connects Puducherry with Chennai. Apart from this the other important roads are NH45A and NH66 also pass through the city.

Railways

Puducherry is connected by broad gauge railway line. Recently, a new train has started from Puducherry connecting Bhuvaneswar City via Chennai.

Port

Puducherry has an old port located near the lighthouse and a new port near Ariankuppam.

Airport
Puducherry has a medium sized airport, but is not functional. The airport in Puducherry is not economically viable due to the presence of Chennai airport which is close to Puducherry.

Demography
With a population of over 7 lakhs, Puducherry region is the biggest region of the State. The demographic and growth characteristics of the region and the four project local bodies are discussed in the following sections.

Population
The Union Territory of Puducherry has a total area of 480 Sq Kms with a total population of 12.44 lakhs as per last census. It comprises of four coastal enclaves in South India. Puducherry is situated 170 Kms south of Chennai. Karaikal 150 kms south of Puducherry while Yanam is about 900 Kms away in the lap of Kakinada district of Andra Pradesh and Mahe in Kerala is 650 Kms away in the west coast.

Keeping in view the need for the investment of investable surplus, the Administration has taken a number of major initiatives to upgrade the infrastructure in Puducherry to boost economic growth in this region. English is a widely spoken language in political and commercial communication. Tamil, English, is the official language of Puduherry and is spoken by more than population. Part from these, languages like Telugu, Marathi, Tamil, Urdu, Malayalam, are also used widely throughout the city.

Population and Growth Trends
Puducherry region has witnessed a rapid growth of population in the past three decades. Especially during the decade 1981-91, the State has grown at a rate of 33.6 percent and Puducherry district at a rate 36.8 percent per annum. The population details Puducherry urban area (comprising of Puducherry & Oulgaret Municipalities and Ariankuppam & Villianur Commune Panchayats) is presented in This rapid growth is attributed to the industrialization and urbanization of adjacent towns such as Oulgaret, Ariankuppam and Villianur. In 2001, the urban area of Puducherry was increased with the addition of Ariankuppam and Villianur.
Population Projection

Population Density
Puducherry has one of the highest densities in the country. The gross density in the urban areas has increased from 5,553 persons per sq km in 1991 to 7,037 persons per sq km in 2001. The increase in density is mostly due to natural increase and due to migration from nearby villages. The population density in Puducherry municipal limits is 11,303 persons per sq km, which has now reached the saturation level. In future the population is expected to grow more in the outer areas. gives the population density in Puducherry urban area.

Year	Population Projection		
	Arithmetic Method	Incremental Method	Polynomial 2 Order
	Nos		
2001	505,959	505,959	505,959
2006	556,952	568,234	1,769,089
2011	607,945	638,030	2,008,059
2016	658,939	715,347	2,264,382
2021	709,932	800,186	2,538,058
2026	811,918	992,427	3,137,469
2031	842,514	1,055,965	3,330,828

Source: Analysis

Economy and Employment

While Puducherry Union Territory has been defined as an administrative unit. It is difficult to clearly delineate the economy as an autonomous entity. Puducherry State consists of four separate geographical areas, viz. Puducherry and Karaikal near Tamil Nadu, Mahe in Kerala and Yanam in Andhra Pradesh. The economy of Puducherry is related to its hinterland. The land area is non contiguous, since there are several enclaves of Puducherry within Tamil Nadu.

Puducherry economy can be characterized as an "open economy" with flows of virtually all factors of production including its location on the sea coast, labour, capital and technology. In 1997 the government announced a new industrial policy for Puducherry to attract investment in the industrial sector there by generating additional employment opportunities. To attract investment the infrastructure will have to be improved.

Tourism plays an important role in contribution of the state economy by providing direct and indirect employment. The city has number of tourist spots including Auroville (located in Tamil Nadu and about 8 km from Puducherry) and heritage structures and the details on presented in Section 6 of this report. It is estimated that over 6 lakhs domestic and foreign tourists visit Puducherry every year. Hence the tourism related infrastructure will have to be developed.

Puducherry is one of the fastest Growing cities in India .it has a diversified economic base anchored by the automobile, software services, and hardware manufacturing, healthcare, and financial services industries. The city is lined with a number of software parks; the most famous among them being the PIPIDIC ELECTRONIC ESTATE, Major electronics manufacturers such as Dell, Nokia, and Samsung have their Indian manufacturing bases in the city. Car parts manufacturers like FORD, Renault-Nissan and Hyundai have established their base in and around Puducherry. In the financial services sector, renowned financial institutions like the World Bank, HSBC, and Citibank have back office operations in Chennai. Chennai's software and biotech sector has attracted businesses such as Wipro, Infosys, TCS, HCL, EDS, Accenture, Sun Microsystems and HP.

Work Force Participation

As per 2001 Census Puducherry has 175,385 workers, of which 91 percent are in tertiary sector followed by 7 percent workers are in primary sector (which includes cultivators and agricultural labourers) and 2 percent are in secondary sector (includes household industries, construction areas). The total work force participation rate in Puducherry is 34.66 percent.

Industries

Puducherry is not rich in natural resources, which would provide the comparative advantage in particular industries, its attraction to investors has been in terms of easy availability of land, water, labour and power and in terms of incentives, concessions and tax holidays. Over the last couple of decades, Union Territory has built up infrastructure which has served as a basis for industrial growth and which can aid growth in the future. Industrial development during the nineties took place due to the implementation of policies encouraging industrial development and due to liberalization. These policies included incentives and concessions with regard to sales tax, income tax and power. The response from the industrial sector was impressive in the nineties and the growth rate for the industrial sector (in terms of value added) between 1993-94 and 1998-99 was 21.09 percent. Beverages, Tobacco and Tobacco Products ,Cotton Textiles ,Wool, Silk and synthetic Fiber Textiles ,Jute, Hemp and Mesta Textiles ,Hosiery & Garments ,Wood Products Paper Products & Printing ,Leather Products, Rubber and Plastic Products ,Chemical and Chemical Products ,Non-Metallic Mineral Products ,Basic Metal Products, Metal Products ,Machinery & Parts (Except Electrical) ,Electrical Machinery and Apparatus ,Transport Equipment & Parts Miscellaneous Manufacturing industries ,Real Estate and Business Service -,Personal Services Repairing and Services not elsewhere classified a number of the major hardware producers are located in Puducherry, namely HCL, WIPRO, IBM etc. Most of these industries located in Puducherry to avail principally income tax concessions. A large hardware industry in Puducherry can help in promoting the software industry. Puducherry has a relatively well trained technical workforce for the software industry though it needs to strengthen its IT training in line with existing market demand.

Industrial Policy

In 1997 Government of Puducherry announced the industrial policy for Puducherry. The major objectives of the industrial policy includes; promotion of sustainable industrialization; maximum utilization of the human resources; improvement of the quality of life of the people; conservation of local environment and heritage and balance regional development

Light Engineering Industry

The industrial policy announced in 1997 gives emphasis to light engineering and auto industry. As the transport sector is growing rapidly in the country, there is considerable potential for development of this industry. This industry is major power intensive industry and Puducherry's low power tariff could act as an incentive to attract more industries here.

Basic Metal and Metal Industries

This industry has been one of the fastest growing industries in the Union Territory over the last couple of decades. Basic metal and metal industries are complementary industries to each other

and are also an important source of components for industries such as the automobile industry. There are over 7500 industries in Puducherry mostly comprising of small scale industries (SSIs). The major industrial estate in Puducherry urban area region is located at Thanttanchavady,

Information Technology Policy

The Union Territory of Puducherry has limited physical resources like land, water, power and raw materials. The environmental factors have also restricted the growth of major industries in the region in spite of attractive financial incentives offered by the government. Information Technology (IT) holds the key to rapid progress and contributes to better governance and improved productivity, which will increase the growth of the economy and quality of life. To make Puducherry a fore runner in the field of IT, a comprehensive IT policy has been prepared. The Objective of IT policy is to provide common man an easy access to information; to make the governmental machinery citizen friendly by facilitating transparency, efficiency and quick decision making in the administration; to create a health investment environment and encourage and accelerate the growth of IT related industries with attractive policies; to establish a good information communication infrastructure

Education

There are 30 High Schools, 70 primary schools within the corporation. There are 6 arts & science colleges, Govt. Law College, Govt. Homeopathic College, Govt. Medical College, Govt. Engineering College, National Institute of Technology, Indian Institute of Management, and other private medical and engineering colleges. The Indian Institute of Spices Research, Centre for Water Resources Development and Management, Centre for Mathematics and Zoological Survey of India are located in the city.

Local Transport

Pondicherry Tourism Development Corporation Limited (PTDC) was incorporated during February 1986 to promote tourism in the Union Territory of Pondicherry. With the introduction of transport service from March 1988, the Corporation was converted into Pondicherry Tourism & Transport Development Corporation Limited (PT&TDC) with effect from December, 1992. The Pondicherry Tourism & Transport Development Corporation Limited on the transport side is operating Interstate buses in 55 routes in all the four regions i.e. Pondicherry, Karaikal, Mahe & Yanam. Through its Inter-State routes, PT&TDC provides direct services to important Tourist places in all the Southern States of India. Once you are in Puducherry you may various modes of the transport, including bet of all you own feet .The spirit of Puducherry is the best captured in walks through the old town s greenery and charming architecture. The historic old city is small, rectilinear, and easy to get around.

Registered Vehicles

The registered vehicle population in study area was 5.2 million in as per last census 2012, 2-wheelers account to around 88% of total vehicles registered. This is an indirect indication of dilapidated stage of public transport (bus) services in the study area. The increase in use of private vehicle directly contributes to increase in total vehicle kilometers traveled and emission levels of pollutants, which would deteriorate the quality of health.

Demographics of Puducherry

Puducherry district has a population of around 1,244,464 according to the census of 2011. The population density is 2,598 per square kilometers. The sex ratio is 1031 females for every 1000 males. **Transport in Puducherry** Being an internationally renowned place for its French legacy, Puducherry provides a great network of roads in all parts of the union territory. There are national highways that run here and join it to other parts of the country. Buses, private vehicles can be found here which are very convenient. There are regular buses that ply from Chennai every half hour. There is also an airport in the Puducherry town. However it is a domestic airport. International airport can be found in Chennai.

Tourism

The place is a true delight for every visitor. Auroville is the most popular destination in Puducherry. The French Quarter, the food, the tradition and the French colony are the attractions here. You can find world class beaches here. So, if you love the sun and the water, youcan enjoy here to your hearts content. The beaches are quite and beautiful. Trees are lined up at the beaches. Besides, there are various monuments that you can see, like the churches, the colonial buildings, temples built during the ancient times, botanical gardens, museums and many more. The attraction here for foreign and Indian tourists is the Aurobindo Ashram built in 1926. It is an educational center and holds a place of respect as well. More

Earlier Studies

Unity Infra Transit Project Implementers System, Transport Project Organisation / Puducherry had made out a detailed traffic study and identified a number of corridors, most of them following existing rail routes, and in addition, This study was made at the instance of Puducherry Urban Development Authority (PUDA) and Puducherry Municipal Corporation (PMC).

Facts about Puducherry	
Area	479 sq km
Population (Census 2011)	1,247,953
No. of Districts	4
Literacy Rate	90%
Road length (total)	2251Kms
Total No. of motor Vehicles	1,41,329 (1995-96)
No. of telephone lines	39,339
No. of telephone exchanges	16
Per Capita electricity consumption	161KWH
Economy	
Net State Domestic Product	26185 lakhs (1996)
Per capita income	Rs 11677
Per capita investment in	Rs 8311 (1995-96)
Demographics	
Location	Southern part of India on the Coromandel Coast of the Bay of Bengal Bounded by Tamil Nadu on its North, West and South
Latitude	Between 11°46' and 12°30' of North

Longitude	Between 79°36' and 79°52' of East
Climate	Warm throughout the year
Max Temperature	31.5°C
Min Temperature	23.9°C
Average Annual Rainfall	130 cms
Languages	Tamil, English, French, Telugu and Malayalam
Religion	Hindus, Christians, Muslims and very few Jains, Sikhs and Buddhists
Best Time to Visit	October to March
Clothing	Cottons throughout the year

Public Transport System

The existing public transports in Puducherry mainly comprise bus system, Seven Seated and Shared Auto rickshaws. The modal share by public transit system in Puducherry at present is about 28% of total vehicular transport demand. This shows that a large proportion of demand is being met by personalized mode of transport, which is resulting in increased road congestion and higher emissions. The ideal modal share in favors of public transport should be 70- 75% for the city of size of Puducherry. Public Transport should be the back-bone soul of a city transport system. The presence of a good public transport System can deliver better environmental conditions, faster speed of travel, better mobility growth and economic growth.

Result of primary survey

The primary traffic surveys carried out as part of this study have brought out the following: The average peak hour journey speed of public transport on the study area road network is about 17 km/h and of private vehicles is about 22 km/h. More than 2.3-lakh vehicles are recorded on More than two million persons cross the everyday.

Rental cycles

The best way to see Puducherry and its surrounding areas is by renting out a pedal cycle. These can be rented from any of the numerous rental stores. Your hotel should be able to provide the contact to the nearest store .Even near Rajiv Gandhi bus stand you can get rental cycle's .But you have to submit some proof to those shops and also advance amount

Rental Bikes

The next cheapest and reliable one is renting a bike .For renting a bike also numerous rental stores are available throughout Puducherry city. You may get information regarding renting a bike in your hotel itself you will need to provide some identification document as collateral and an advance of RS/$ many of the rentals also provide delivery and pickup at the hotel which is very useful.

Cycle Rickshaws & Auto Rickshaws

Numerous number of auto rickshaw's and limited number of cycle rickshaw's are available in Puducherry .The minimum charges for hiring a auto rickshaw is to cost both the . Rickshaw's are available near the entrance of Rajiv Gandhi bus stand, exactly near the Tamil poet Thiruvalluvar statue in the bus stand.

Tempos

One of the way to roam around Puducherry city. Mostly these tempos are operated within ia n the city limit only, maximum they cover a distance of 5 to 6 kilometers per trip .By using tempos you reach Puducherry beach, raj nivas, Jawaharlal Nehru Street, Botanical Garden, Bharathi PARK, AUROBINDO ASHRAM, MANAKULA VINAYAGAR temple. Tempos stand exactly in the entrance of Rajiv Gandhi Bus Stand Puducherry.

Town Bus

Town buses are also available in Puducherry. But its difficult for a new tourist. Because mostly town bus write-ups in tamil only .It could be difficult for a new one to find out the exact bus .By using town bus you can reach Chunnambar Boat House ,Usteri Lake , Auroville etc. the prominent way to travel around Puducherry is renting a bike. If you want to enjoy the entire beauty of Puducherry and its infrastructure then pedaled cycle is the only choice.

Rail Network

Puducherry is connected by a railway branch line from the five-way junction at Villupuram Town. The railway line is being gauge converted meter gauge to broad gauge.

Road Network

Puducherry is endowed with excellent infrastructural facilities on par with the best available in the country. A network of all weather metalled roads connecting every village exists in the territory. Has a road length of 2552 km (road length per 4.87km), the highest in the country. Traffic Demand Projection The study area consists of Puducherry Urban Development Authority area, Municipal Corporation area and study area totals to 290 Sq.Km sq. km. As part of the study detailed traffic surveys were conducted to prepare the database for working out traffic demand.

Traffic Characteristics

The traffic volume data has been analyzed to derive the peak hour traffic volume, composition and hourly variations. The volume is converted in to equivalent passenger car units (PCU'S) as per Standards of Indian Road Congress

Occupancy Rate

The occupancy rate for car, auto and two wheeler are 3.5, 1.9 and 1.5 respectively.

Parking Surveys

Parking surveys were done to assess the demand for parking by various types of vehicles at identified terminals and corridors.

Methodology

The existing demand for on-street parking facility was determined by patrolling the parking area at regular intervals. The information collected included the road length, Number of vehicles parked on street and the traffic population along the corridor.

Parking Space Utilization at Terminal Surveys

The usage of the existing parking facility, if available, at the specified terminal is assessed in this survey. No. of vehicles parked in the terminals and their registration numbers were noted down to determine the duration of parking.

Speed & Delay Surveys

Speed on a road section is governed by volume of traffic, its composition, roadway features, and environment. The principle objective of the study is to find out the journey speed, running speed and types of delay such as stopped delay and operational delay to evaluate the level of service or quality of traffic flow of a road or entire road network system.

Methodology

The survey is conducted during peak and off-peak hours on any normal day using moving observer method. The survey vehicle (car) is moved in the stream of traffic at the speed as of other traffic during different times of the day in both peak and off peak times. The delays and corresponding causative factors at intersections / major activity centers etc. is collected to identify major bottlenecks on the road.

Studies

Car In this survey, enumerators traveled in the car along the stream of traffic at the speed as of other traffic during different times of the day in both peak and off peak times. The delays and corresponding causative factors at intersections / major activity centers etc. were collected to identify major bottlenecks on the road. For this survey, 3 cars shall be employed in three different routes in the network.

Sub-project Rationale and Design Criteria

Service inadequacy across various spectrums of transport planning and traffic management requires undertaking appropriate measures to improve traffic mobility in Puducherry. With a view on catering to the existing traffic demand, traffic management and improvement measures are required in the immediate and short-term.

Travel demand for the future cannot be met with the present level of modal split. Hence, a policy intervention is imperative to affect a modal shift in favor of public transport, more particularly by bus in the absence of a rail network, which will cater to intra city traffic.

National Urban Transport Policy2 (stipulated by the Government of India). Sub-project identification is governed by the following factors:

- Planning traffic and transportation for catering to travel demand,
- million-population transit,
- Identifying measures to decongest the city-centre,
- Identifying appropriate transport infrastructure location, specifically in newly developing areas detailed through Town Planning schemes,
- Planning a balanced land use-transport interaction focusing on public transport
- operations in newly planned areas,
- Developing transport facilities catering to local traffic and providing unhindered traffic

flow on major roads,

- Providing adequate infrastructure facilities for pedestrians and cyclists and encouraging non -motorized transport (NMT),
- Developing an appropriate and suitable public/mass rapid transit system,
- Developing an Intermediate Public Transport system to play a complementary role to the Public Transport system,
- Developing a robust Asset Management and Maintenance system for catering to long term asset sustainability, and Adopting appropriate Project Structures to ensure effective traffic management and Transportation provision in the city.

Sub-project Identification

The City Development Plan proposes to undertake the following sub-projects:

- Traffic Control Devices. Traffic signs and markings, and traffic signals.
- Area level improvement measures. The central area of Puducherry within the Boulevard ring road is characterized with road network in grid pattern. The area level improvement measures include proposals for one-way movement, restriction on traffic movement (mode wise and time wise), parking restriction and pricing of parking and road signage and marking etc.

Traffic Management Schemes

High traffic volumes at the intersections beyond their design capacity cause delays, congestion and accidents. The efficiency of the road links and intersection can be improved by enforcing proper traffic controls and with proper traffic management techniques. These traffic management measures are recommended without any change in the geometry of the respective roads and intersections or with minimum engineering inputs. The traffic management measures are recommended after analysis of the existing facilities for their capacities.

It is recommended to be modified/improved the circulation pattern for the roads MG Road, Mission Street between Lal Bahadur Street and Sardar Valla Bhai Patel road. Based on renaissance survey and traffic surveys it is propose one way movements on MG Road and Mission Street. On MG Road the movements may be restricted only from south to north and on Mission Street the movements is proposed from north to south. On these one way streets movements of two wheelers in opposite direction should not be permitted. One way stop controlled locations. The advantage of this system is control on conflicts and increased speed in the main road. This type of management schemes is proposed under the area level improvement schemes at some selected intersections. This type of management measures is introduced where a minor road joins with very high traffic movement. In this management technique higher priority is given to the vehicles on major roads and vehicles coming from the minor road should wait before crossing main road. This will ensure smooth movement of traffic in the major roads. This type of treatment is generally followed in non-signalized intersections. Such type of roads which needs stop and go control is identified in the Boulevard Area.Improvement at intersections within Boulevard. The road network in Boulevard area has a grid pattern formulated by the French. Western side of the

area has concentration of activities like shops and whole sale and vegetable markets. This area is characterized by traffic congestion and delays at intersections.

One of the main reason for this is unauthorized and haphazard parking close to the intersection and encroachment of footpath by vendors forcing the pedestrian to move on the carriage way. The haphazard movement of pedestrians close to the intersection areas also add to the confusion at these locations. Most of the intersection in this area lack proper sign board and road marking. Anna Square, Raja Theatre junction and Ajantha theatre junction are major intersection in this area wherein study the traffic volumes. Pedestrian Subways/ Over Bridges. Ajantha, Pattanikadai, Odiansalai, C.V.Road, New Bus Stand, Nellithope, Marapalam, Rajiv Gandhi Square, Indira Gandhi Square, JIPMER Entrance and Periyar Statue Road Improvements. Strengthening and widening of existing roads were ever possible, asphalting existing roads, street lighting and high mast lighting, off-street parking (MG Road, Kamaraj Salai, Cuddalore Road, Gopalkadai Road, College Road, Buvancare Road, PWD Bypass, IG Reddipalyam, Vannerpet Road, Veerampattinam-Thenjaittu road, Vazhudur road and Villupuram road.

Parking Facilities

The existing parking is done on roadside and the local body does not collect any parking fee. But due to the presence of large number of private vehicles mostly comprising of two wheelers has led to demand for additional parking space. Hence there is a need for additional parking facilities in market area in Boulevard area and the central jail premises can be converted into multilevel parking facility on a Public Private Partnership basis.

Flyovers at Intersections

Flyover along ECR bypass (Indira Gandhi and Rajiv Gandhi intersection to be a grade separator), ROB at Arumpathapuram – Four lane carriage way.

New Links

Provision of by-pass to Villupuram road connecting Armbathurpuram and ECR by-pass along southern side of the railway line.

Peak Area

Sl.No	Location	Road Name
1	Subhash Chandra Bose Salai-Ambur salai	Ambur salai
2	Annasalai-Ajantha	West Boulevard Road
3	Ajantha-Beach Road	North Boulevard Road
4	Beach Road-Ajantha	North Boulevard Road
5	Bharati st-Ajantha	Bharathi Road
6	Bharati st-Railway Station	South Boulevard Road
7	Cuddalore-Puducherry	Cuddalore Road
8	Cuddalore-Cuddalore	Cuddalore Road
9	Gorimedu-Pondy	Road from Gorimedu towards Pondicherry
10	Annasalai-Anantha	West Boulevard Road
11	M.G.Road-Ajantha	M.G.Road

12	M.G.Road-Kazimarket	Road from Villianur towards Pondicherry
13	Villianur-Puducherry	Vaikka street
14	Vaikka street-Railway Station	Uppalam Road
15	Uppalam Road-Cuddalore	Uppalam Road
16	Uppalam Road-Beach road	Beach Road

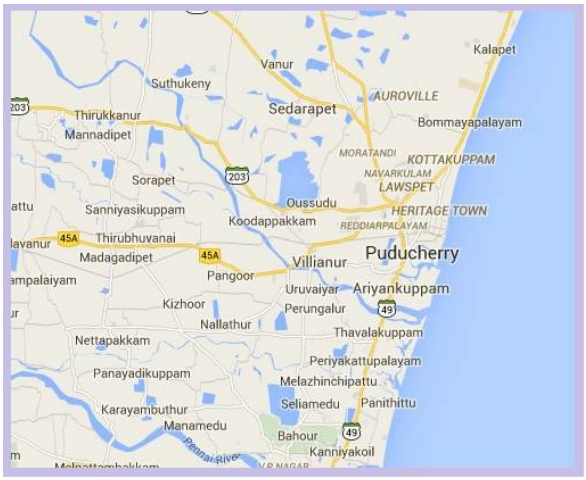
Fast moving vehicles

Fast moving vehicles	PCU	MAV	4.0
Car & Van	1.0	Two Wheeler	0.8
Mini Bus	1.5	Auto	2.0
Standard Bus	2.2	Carts	8.0
LCV	1.4	Slow moving vehicles	PCU
2 Axle Truck	2.2	Agricultural Tractor & Trailer	4.0
3 Axle Truck	2.2	Cycle	0.5
		Cycle Rickshaw	2.0

Peak Hour Area Volume

Sl No	Location	Peak Hour Volume	
		Vehicles	PCUs
1	Subhash Chandra Bose salai-Ambur salai	2,188	1,409
2	Anna salai-Ajantha	2,199	2,643
3	Ajantha-Beach Road	687	562
4	Beach Road-Ajantha	1076	588
5	Bharati st-Ajantha	1047	601
6	Bharati st-Railway Station	1,056	964
7	Cuddalore-Puducherry	1,916	1,796
8	Cuddalore-Cuddalore	1,813	1,694
9	Gorimedu-Pondy	2,185	1,694
10	Ajantha-Annasalai	3,964	4,045
11	M.G.Road-Ajantha	923	904
12	M.G.Road-Kazimarket	923	902
13	Villianur-Puducherry	844	1,343
14	Vaikka street-Railway Station	1,034	852
15	Uppalam Road-Cuddalore	1,542	1,565
16	Uppalam Road-Beach road	2,595	2,136

9.12-Puduvai Trans Stations



PUDUCHERRY MAP

Puduvai Trans rapid system Route Plan And Station Location Measurement				
No	Station Names	Area Names	Length	Chainage
1	Kurinchi	New Bus Stand	0.00	0.00
2	Malligai	Botanical Garden	935	935
3	Thamarai	Raja Theatre	718	1653
4	Culli	Ajantha Signal	931	2584
5	Vaagai	Bell tower	1010	3594
6	Nanti	Muthailpet	1027	4621
7	Maruthum	Kottakuppam	960	5581
8	Venkai	China Chavady	1102	6683
9	Mullai	Auroville	1073	7756
10	Cemmal	Boomayampalayam	1014	8770
11	Aavarum	Vanur	1036	9806
12	Alli	Pillichavady	1113	10919
13	Karanthi	Engineering Collage	1656	12575
	Depot 500 Meters	Depot	500	113075
14	Thilakam	Puduvai university, kalapet	1428	14503
15	Arumbu	Kalapet	1282	15785
16	Puduvai	Ganapathichettikulam	1410	17195


PUDUVAI TRANS RAPID SYSTEM
ROUTE MAP
Puduvai 1410m
Arumbu 1428m
Thilakam 1282m
Karanthai 1656m
Alli 1113m
Aavaram 1036m
Cemmal 1014m
Mullai 1073m
Venkai 1002m
Marathum 950m
Nanti 1027m
Vaagai 1010m
Culli 931m
Thamarai 718m
Kurinchi 0.0m
Malligai 935M
Auroville
Kullapalayam
Periya Mudaliar Chavadi
Chinna Mudaliar Chavadi
PONDICHERRY AIRPORT
Pondicherry (Puducherry)
2.0 km
3.0 km

Why use the Maglev Magnetic Two-tier Monorail

The greater distance between stops can be covered very rapidly by the ultra light weight Two-tier Maglev Monorail at key locations along the proposed System. Detailed Study for examining feasibility traffic and transport data was collected through fresh surveys, zone system and transport network was developed. Mode wise origin destination passenger matrices were also developed from road side interview data. Data on demography, land use, potential growth centers and existing transport system was analyzed and heavy traffic flow corridors were identified. Several alternatives which include both different modes of transport and different alignments were tested. By following standard procedure and after conducting a full investigation, one of the alternatives was recommended for Two-tier Maglev Monorail System to be implemented in the transport plan.

Station

Stations have emerged as a new central place in metropolitan cities and have become hub of networks due to their high accessibility by different modes of transport in high scale level. Furthermore, they produce movements which offer sufficient opportunity for the development of commercial land use. Railway stations entered a new age again in the late 20th century after the introduction of high-speed trains. Stations play a very important and influential role in the Maglev Magnetic Two-tier Monorail transport system. The efficacy of the Maglev Magnetic Two-tier Monorail system over the national and regional development depends on the stations. The development hub of Maglev Magnetic Two-tier Monorail system mainly formed around stations
Transportation facilities are both collectors and distributors. The overall goal of these transit stations is to collect and distribute as many passengers as possible with a minimum amount of confusion and inconvenience. Stations should have the capacity to accommodate large concentrations of passengers at various times throughout the day. The stations activities consist of everything from passenger service to the maintenance of the building. It is important to provide the traveler with a pleasant experience and atmosphere that will hopefully lead to repeat business in the future. The station should be able to provide for all of the modern conveniences to better serve the employees as well as the weary travelers.

The important idea is to be able to get the people to their next destination as quickly as possible, and if a wait happens to occur then the station should be equipped to accommodate the passengers' needs.

Maglev Magnetic Two-tier Monorail stations are key regional transportation facilities designed to provide access for high volumes of passengers. The aesthetic features of the stations are intended to reflect the intrinsic values of the Maglev Magnetic Two-tier Monorail system advanced technology, movement, and speed. The conceptual design calls for open air stations with natural light and ventilation.

Fundamentally, a Maglev Magnetic Two-tier Monorail station is equivalent in planning, design, and operation to an inter-city or commuter railroad station. There is only one technical aspect of Maglev Magnetic Two-tier Monorail that constrains station design: unlike railroad tracks, the Maglev Magnetic Two-tier Monorail guideway cannot be crossed by passengers and vehicles at

grade. As a result, Maglev Magnetic Two-tier Monorail station designs must provide grade separated passenger access to the station platforms. This form of access requires "vertical circulation" (stairs, elevators, escalators) to connect the platforms with tunnels under or bridges over the tracks. Stations should provide the proper functions of typical transit stations, including platforms, Shelter, Vertical and Horizontal circulation, Amenities and Services, Climate controlled waiting room, Public restrooms, Snack service, Public telephones, Changeable message display, Safety. All the station designs are planned to be consistent with the character of the buildings in the area of operation or predicated on the community standards of the local area where each station is located. The station must support the safe movement of passengers at specified flow rates and must also support particular levels of vehicle traffic. Based on the patron markets the following elements, features, and design standards should be common to all Maglev Magnetic Two-tier Monorail system stations, regardless of location or patronage volumes. The expression of these standards will vary and additional features may be added, depending on station location.

Stations are planned to be located at 16 stations the main station being The Rajiv Gandhi bus stand to Ganapathychettykulam via Puducherry university – Kalapet.

Station Planning and General Design

This section lays down the standards for planning and design of stations. The station shall enable a safe, reliable, cost-effective and customer oriented public transport system. Safety of Users, the public and operating personnel shall have the first priority. The Station shall be visually appealing; open, spacious, well lit and consistent with the environment. The Station planning shall permit maximum cross ventilation and natural light for the Station as well as for the roadway below the Station. The space and facilities at Stations shall satisfy functional requirements in the peak hour for the target year under all operating conditions. Facilities shall be provided for handicapped persons. Location of Stations is indicated in the DPR. Change in location of Stations along the already finalized alignment is permitted to minimize relocation of existing features and to provide better connectivity and traffic integration. The overall width of Station structure shall be limited to be within the road width including foot paths. Where Stations are located outside the road land width, the overall width shall be governed by site conditions. Road clearance shall be 5.5m (min) at concourse level at Stations. This clearance of 5.50m shall also be available outside the Station area on road side beyond vertical plane drawn on outer face of crash barrier of elevated guideway supporting column. Site Access and Circulation. Circulation patterns for traffic within Station sites and on approaching streets shall be site specific, and shall consider:

- Integration of Stations with the existing urban fabric, merge with the surroundings, respect for local traditions, and minimize visual intrusion into the urban landscape,
- Separation of traffic modes to allow convenient, safe and rapid access to and from Monorail facilities and
- Passenger design loads for the Rail System.

Access Modes

The Stations shall be designed in a manner that enables Users to arrive at and depart from the Stations via the following modes:

- Pedestrian walk-in,
- Scooter and cycle with **NO PARKING** facility. Because there may not be enough land available, since the land will be allotted **only** for the construction of the station. If any parking is required, some third-party may acquire land for parking on their private basis.
- Buses, Taxi, auto-rickshaw, cycle-rickshaw and car drop-off.

Site Circulation Parameters

- Site circulation and Station circulation shall be separated vertically, in most cases, with the station above the site circulation.
- An entrance shall be visible from the bus-loading area, if possible and at a minimum shall be easily accessible from the passenger loading area. Covered access from the vehicle drop-off areas to the Station entrance shall be provided.
- Station and property development circulation shall be separated as far as possible.
- Site circulation layouts shall be simple and direct, allowing easy orientation for drivers and facilitating movement of pedestrians.
- Where conditions permit, roadways shall be one-way circulation, with turning loops eliminating intersections and conflict movements within the site. Sightlines at merges or intersections shall be left clear.

Station Architecture

The Stations being windows to the Monorail service, shall be visually appealing, tastefully designed reflecting local culture and flavour, functional aesthetics, user friendly, energy efficient and with a Station architecture that is site specific and environmentally compatible. The design should identify significant architectural features which should be taken into account.

Station Quality

- The considerations in a quality design are:
- Aesthetic and functional qualities are to be incorporated,
- appropriate roof and ceiling heights should be provided,
- unobstructed large span structural systems should be adopted,
- facade and other structural systems should provide adequate weather protection and natural light. The design should make efficient use of space which aesthetically integrates lighting, communications, ventilation; and electrical and mechanical systems and
- Provision for free and safe flow of Users, with adequate queuing space at all passenger service areas without disrupting normal User flow.

Spatial Vertical Clearances

- All public spaces including stairs and ramps shall have a minimum ceiling height or vertical clearance of 3 m.
- All non-public spaces including stairs and ramps shall have a minimum ceiling height or vertical clearance of 2.4 m.

Pedestrian Access

- Direct and safe approaches for pedestrians shall be provided into the Station area from all adjacent streets.
- Pedestrians shall have the right-of way over vehicle at crossings of internal roadways.
- Pedestrian crossings shall have good visibility for both pedestrians and road vehicle drivers.
- Pedestrian crossings at streets wider than four traffic lanes shall have a refuge area in the median.
- At all pedestrian crossings, kerb cuts shall be provided for persons with special needs. All kerbed cuts shall be marked with signs.

Pedestrian crossings shall be emphasized with textured pavement of crosswalk marking. Where major pedestrian paths cross roadways, the paving material, or a material of similar color, shall be carried across the roadway to emphasize the pedestrian right-of-way, the parking pattern shall allow pedestrians to walk toward the Station with a minimum of traffic crossings.
Dimensions of pedestrian walkways and crosswalks shall comply with The Indian Roads Congress (IRC) codes and standards.

Vehicular Access

- Vehicular entrances shall be located to distribute traffic loads evenly over the site.
- Vehicles shall enter from secondary roads, wherever possible, with provision of space for short waiting periods.
- Entrance and exit from Station parking shall be separated, where possible, from those of bus and auto drop-offs.
- Emergency vehicle access shall be provided to all building structures, especially the Station entrances. Station access roads and parking lot perimeter roads shall accommodate emergency vehicles including fire trucks.

Station Design Requirements

Station Configurations

- Stations shall be designed for peak flow of user traffic and the requirements of future Train services and shall follow NFPA.

The following elements are to be designed and provided for,

- Adequate ventilation and lighting for the road users below,

- ticket counters/Automatic ticket vending machines (should be provided before access to gates/validates),
- User amenities to help in decentralizing customer volume and to facilitate easy maintenance,
- space for passenger operated machines (Automatic Ticket Dispensing Machines) for future,
- passenger kiosks and commercial kiosks,
- customer service center,
- emergency evacuation exits,
- AFC system and AFC gates,
- parking and circulation area for traffic integration,
- Station entrances and exits to allow for entry/exit of Users under normal and emergency conditions, with doors opening both ways,
- lifts and stairs,
- on line Passenger Information System including digital clocks and PA system,
- signage's, name boards and route maps,
- requirements for physically challenged Users' and senior citizens,
- landscaping works,
- security alarm and fire protection system to be located in Station manager's room complete with firefighting equipment as per requirement of concerned authorities, and
- Lightning protection and primary surge protection system for incoming power supply to the building and for sensitive relays and electronic equipment.

Design Features for General Station Security

The Station design should be such as to promote real and perceived security for the Users. The following features shall be incorporated in Station design to maximize safety and security of the Monorail system and its users. Stations shall be open, spacious and well lit so as to maximize visibility of people, platform, other building/structure areas, and parking areas.

- Hiding areas shall be minimized.
- Access points to parking area shall be minimized.
- Adequate lighting shall be provided, minimizing shadows and avoiding dark areas.
- Shatter guard protection shall be provided for glass windows/doors.
- Transparent material for door of the cabin of stair wells and elevators shall be provided.
- Planning shall provide for open lines of sight to as much area as possible.
- All passenger routes of travel shall be clearly defined, and shall be direct, well lit and with good visibility.

The Station design shall conform to the following standards:

- The Persons with Disabilities Act.
- National Building Code.

- NFPA 70-National Electrical Code.
- NFPA 72-National Fire Alarm Code.
- NFPA 130-Standard for Fixed Guideway Transit and Passenger Rail Systems.
- Handicap Accessibility.
- The Railway System design shall conform to the following reference standards and Regulations.
- The Persons with Disabilities Act.

International Building Code as applicable to,

- Planning and Design Principles,
- safety and security,
- Station layout,
- access to Station and circulation,
- waiting area and ticketing,
- toilets – public toilets to be provided in non-paid areas and in commercial areas.

Lighting, signage and graphics, Furniture fixtures and equipment, Information Displays,
Signage's shall be user-friendly and shall provide information essential to Users, engendering a sense of reassurance, security and orientation when entering, exiting or transferring. It shall Guide Users to various Station areas, provide information of the Station and its services and provide information on Train services.

- Essential public information signage's shall be of retro-reflective high intensity prismatic boards or equivalent.
- User information shall cover the following as the minimum,
- Static signage's such as Station name, destination of services, platform number, position of doors of Coaches, way finding signs, direction, entry, and exit,
- variable signage's such as real time travel information to customers,
- maps and long term changeable information on scheduled services,
- information on the use or operation of a place or system,
- intermodal connections,
- emergency exits, and
- Rules of conduct to Users.
- Major information to Users such as direction, entry, exit etc shall be in letters of size not less than 300mm. For other information, size and color code shall be decided in consultation with the IE.
- All signage shall have alternate pictorial signage of same size as the letters.
- The technical fabrication details for the fixed hardware system shall be in accordance with security requirements.

- The following principles shall be followed for placement of signage:
- User information displays should be so located that Users seeking information have ready access without obstructing free flow of Users,
- signs shall be placed at decision points, and perpendicular to the line of sight,
- Signage's shall be placed on the left side of passages including stairs, lifts and escalators.
- Lighting levels shall be so designed that general lighting does not overpower the light emitted by signage's.

Advertisement

Advertisement installations may be installed in public areas and at Station site areas including at inter-modal transfer facilities.

- Advertisement installations shall not adversely impact Monorail operations, Station circulation pathways or create safety hazard and shall be compatible with Station design including signage and art installations
- Commercial third party advertising or news messages shall not be combined with messages to Users on railway services.
- The installations shall be of standard sizes with fire resistant/ non-combustible materials.

Emergency egress

Station design should allow safe evacuation of occupants in an Emergency. For egress/fire evacuation measures, the Station design shall meet the requirements for stations as provided in NFPA 130- 2007 Edition, Section-5, and Item 5.5 - Means of Egress. Fire detection and suppression shall be generally as per NBC For calculation of occupant load, projected ridership figures or maximum Train load capacities as per future plan, whichever is more shall be used. Occupancy at the time of evacuation should be based on peak usage with 5 minutes delay to the scheduled Train service in the busiest direction only. Users waiting to board and those normally alighting from the next Train in each direction should be evacuated.

Each Station shall have a minimum of two main access/egress points remotely located from one another. There shall be sufficient exit to evacuate the Station occupant load from the Station platform within the time period prescribed as per NFPA 130 standard. The maximum travel distance to an exit from any point on the platform shall not exceed 100 m.

Fire Precautions

- The choice of materials in public areas of Stations should be such as to keep the fire load and the smoke and toxic gas generation in the event of a fire to the minimum practicable level.
- An electrical fire alarm should be provided for manual operation by Users/staff, and installed in accordance with IS 3218: Code of Practice for Fire detection and Alarm Systems. Public Address System should be protected as per provisions of IS: 3218.

- The non public areas should be provided with a warning cum address system to alert staff inside plant and machine rooms.
- Firefighting equipment should be provided as per Applicable Law.

Performance Requirements

Centralized control of the Station E&Ms.

- All Stations shall have a dedicated central management unit of all major E&M equipment so that the maintenance staff can have control over them. The equipment under local central command shall include the following as a minimum:
- The entrance closing gates of the Station,
- lighting, and Lifts.
- The local central management unit shall be the relay to the OCC
- For dealing with Emergency, the control should also have the following:
- An Emergency procedure information system,
- a means of monitoring fire detection systems,
- a means of summoning Emergency services,
- communication system,
- public address system,
- a means of monitoring operation of lifts, escalators, ticket barriers and other equipments, and CCTV monitoring of all Station areas.
- Security Management Systems (SMS).
- Operating panel buttons shall be a minimum of 50 mm diameter and shall also have the operation of the button superimposed on it in Braille. A ventilation opening or duct to open air of area 0.3 m^2 or, 3.5 % of the cross-section of the elevator shaft, whichever is greater shall be provided at the top of each elevator shaft.
- The ventilation openings shall have a minimum free area of 0.3 m^2, or 3.5% of the cross section of the elevator shaft, whichever is more.
- Additional codes and standards applicable are as follows:
- IS: 14665; IS: 15330; IS: 7759; IS: 1860; IS: 15785:
- "Guidelines and space standard for Barrier free Built Environment for Disabled and Elderly Persons" published by the CPWD (Central Public Works Department) India. Guidelines for safety of elevator circulated vide A. V. series circular no. 822, issued by the Ministry of Urban Development and Poverty Alleviation, Govt. of India vide their letter no. C-31011/1/2001-AVII, dated 7.12.2001.

Stairs

- All steps in a flight of stairs should have the same dimensions.
- Tread of steps should be minimum 300 mm.

- Riser shall not be more than 150 mm.
- Hand rails shall be provided at a height of about 900 mm.
- Step noses shall be rounded and color contrasted.
- Minimum width of stairs shall be 1500 mm.
- Minimum head room over a stair shall be 3.0 m.
- The stairway must be well lit.

Materials and Station Finishes

The materials selected and finishes adopted for floors, walls and ceilings should provide comfort and safety, improve the aesthetics, be durable, operable and maintainable with minimum resources. The materials chosen should be durable, fire resistant, vandal resistant, environment friendly and pleasing.

Contrast

Platform edge strips shall be of visually-contrasting material.

Unavailability of Station space

In some cases, if the Puduvai Trans is not able to find or allocate space/location for a particular station along the 17.200 Km stretch. The Puducherry Government will have to provide the appropriate space and location for a station on their own under feasible conditions. The space provided by the Puducherry Government should be correct in all dimensions to set up the particular station as per the station plan (design).

All the elevated stations have been planned along one side platforms. Care has been taken to locate stations on straight alignment only. The sequence of stations along with their respective chainages, site and platform characteristics are presented below.

Station Location Characteristics

Name of station 1	**Kurinchi - Main Terminal**
Type of station	*Elevated G+1st+2nd*
Station location	*Rajiv Gandhi Bus Stand (New bus stand).*
Inter station distance	*00.00*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Catchment area	*This station is located right inside the premises of the Moffusil Bus stand and at the Maraimali Adigal Salai road.*
Name of station 2	**Malligai**
Type of station	*Elevated G+1st+2nd*
Station location	*Botanical garden.*
Inter station distance	*935m*
	This station can be located near or inside the botanical garden premises.

Entry/Exit Stairs	*Bus stand*
Catchment Area	*This area is the main heart of Puducherry. It has comfortable access to cinema halls, GH, beach, shops and residences as well.*



Type of station	*Elevated G+1st+2nd*
Station location	*Opp site raja theatre(station private property)*
Chainage	*1653 M*
Inter station distance	*718 M*
Rail level	*Two-Tire Maglev monorail 15m above road level.*
Station	*This station is located in the junction of Jawaharlal Nehru St and RangapAlli Street. (Opp Raja theatre).*
Catchment Area	*All types of business establishments are present here. One of the important places in Puducherry.*



Name Of Station No 4	***Culli***
Type of station	*Elevated G+1st+2nd*
Chainage	*2584M*
Inter station distance	*931M*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Station	*Near Ajanta signal or adjacent to canal or private land has to be acquired.*
Catchment Area	*Main source of passengers to this station is from The Barathidasan college, Ajanta signal, near by schools, residences, offices, business establishments and high-class hotels, business people and office bearers living*

	in area, passengers travelling along the Sardar Valabhai Patel road and passengers coming for shopping to this commercial area.



Name Of Station No 5	***Vaagai***
Type of station	*Elevated G+1st+2nd*
Station location	*Muthialpet Bell Tower*
Chainage	*3594M*
Inter station distance	*1010M*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Station	*Near Kalapet Pac Bank Ltd*
Catchment Area	*Main source of passengers to this station is from Manjini Nagar. localities, Vaithikuppam(1KM), Nonankuppam (1 KM), Angalakuppam(1 KM), Chevarapet (1 KM), Vazhakulam (1 KM), local business centres, shops and residents of theocality.*



Name Of Station No 6	***Nanti***
Type of station	*Elevated G+1st+2nd*
Chainage	*4621M*
Inter station distance	*1027*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Station	*Muthailpet.*

Catchment Area	*Private land has to be purchased for this station. Main passenger traffic includes mid- sized business establishments, local workers, residences, nursing homes and schools.*



Name Of Station No 7	***Marathum***
Type of station	*Elevated G+1st+2nd*
Chainage	*5581M*
Inter station distance	*960M*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Station	*Kotakuppam.*
Catchment Area	*Mother residency, local workers coming to town from the eastern suburbs of the city.*



Name Of Station No 8	***Venkai***
Type of station	*Elevated G+1st+2nd*
Chainage	*6683M*
Inter station distance	*1102M*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Station	*ChinnaChavadi.*
Catchment Area	*Private land has to be acquired. Mid-sized business establishments, local residences, hospitals.*



Name Of Station No 9	Mullai
Type of station	Elevated G+1st+2nd
Chainage	7756M
Inter station distance	1073M
Rail level	Two – Tire Maglev monorail 15m above road level
Station	Auroville.
Catchment Area	World class tourist attraction, hospitals, schools, shops, beach resorts, developing towns are nearby.

Name Of Station No 10	Cemmal
Type of station	Elevated G+1st+2nd
Chainage	8770 M
Inter station distance	1014 M
Rail level	Two-Tire Maglev monorail 15m above road level
Station	Bomayampalayam.
Catchment Area	Tourist attraction area, guest houses, beach resorts. Rajeshwari college of science, government law college.

Name Of Station No 11	Aavarum
Type of station	Elevated G+1st+2nd
Chainage	9806 M
Inter station distance	1036 M
Rail level	Two-Tire Maglev monorail 15m above road level
Station	Vanur.

Catchment Area	*Scarcely developed area.*

Name Of Station No 12	***Alli***
Type of station	*Elevated G+1st+2nd*
Chainage	*10919 M*
Inter station distance	*1113 M*
Rail level	*Two –Tire Maglev monorail 15m above road level*
Station	*Pillaichavadi*
Catchment Area	*Private or government place has to be acquired here. Four engineering colleges are situated near pillaichavadi. Also headed by local residences.*

Name Of Station No 13	***Karanthai***
Type of station	*Elevated G+1st+2nd*
Chain age	*12575 M*
Inter station distance	*1656 M*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Station	*Pondicherry Engineering College.*
Catchment Area	*Students, local residences. Government has to provide land for the station.*

Name Of Station No 14	***Thilakam***
Type of station	*Elevated G+1st+2nd*

Chainage	*12575 M*
Inter station distance	*1656 M*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Station	*Puduvai University, Kalapet.*
Catchment Area	*Students of Puducherry University, schools and local residences and petrol bunks. Govt has to allocate land for this station and also for Depot (approximately 5 acres).*



Name Of Station No 15	***Arumbu***
Type of station	*Elevated G+1st+2nd*
Chainage	*14003 M*
Inter station distance	*1428 M*
Rail level	*Two-Tire Maglev monorail 15m above road level*
Station	*Kalapet.*
Catchment Area	*Chem Fab factory, PIMPS, Teaching Institute, hospitals, local residences. Govt land or private land has to be acquired.*



Name Of Station No 16	***Pudhuvai***
Type of station	*Elevated G+1st+2nd*
Chainage	*16695 M*
Inter Station Distance	*1410 M*
Rail Level	*Two-Tire Maglev monorail 15m above road level*
Location	*Ganapathichettikulam*

Catchment Area	*Private or Govt has to provide land for the station. Medical college, business schools, schools and local residences.*



Signaling and Telecommunication

The most advanced communication based train control (CBTC) system, generally conforming to IEE 1474 and ATS (Automatic Train Supervision) has been proposed. Signaling and train control system will be capable of running trains at operation headway up to 120 seconds (design headway of 100 seconds). Provision for automatic train operation as well as driverless train operation has been kept.

Driverless Train Operation

In a driverless operation system, trains run without a driver in the cab. Train operation and status is remotely controlled and adjusted from the OCC based on the two-way Radio Frequency Communication Based Train Control (CBTC). This high-end system minimizes faults and operation delays through securing redundant systems and automatic route change functions. This operation system also ensures safety through minimizing human error, which accounts for the largest portion out of the cause of railway accidents. For certifying the signaling system an independent safety assessor will be required to audit the signaling system and suppliers process and approve the same for safety certification. The main bearer of the bulk of the telecommunication network is proposed with optical fiber cable system. Considering the channel requirement and keeping in view the future expansion requirements a minimum 48 optical fiber cable is proposed to be laid in ring configuration with path diversity. There will be passenger announcement system, passenger information display system, centralized clock system and closed circuit Television (CCTV) system at all stations. In addition, there will be mobile radio communication between the trains and operation control centre (OCC).

Traction and Power Supply System

They are renewably powered or run off the electric utility grid. It is a monorail type light rail system that is low cost and reduces energy requirements. This is due to the use of efficient traction energy, recapture of energy when braking for reuse when accelerating, and the re-arranged steel reinforced concrete track structure designed to simplify and reduce materials. Passenger rail cars can use light-weight composite materials as well. We use a standard innovative mix of rail and automotive components. These materials are long lasting, well tested, and require little maintenance. This further lowers energy demands, costs and effects on the environment.

Using renewable power sources that tend to be low in high power electricity output is now possible by capturing, condensing and storing this energy. The ET solution uses continuous power storage to overcome this lacking and has it available for the next arriving vehicle. Upon sensing vehicle arrival at a station the ET system quickly transfers this stored power to the vehicle and stays connected for up to a minute using station power to accelerate the vehicle saving stored power already on the vehicle. Other criteria improved upon were the capture and rapid transfer to a secondary storage device onboard the vehicle that would make it possible to eliminate power source wires (catenaries) typically used over the whole route on other transit systems.

The use of quick charge power accumulators, the Ucaps, reduces the peak power from a source, decreasing size and cost of substations. Current systems use a substation costing over $400,000 each connected to high voltage and power. These use high output for small durations of time causing variations of voltages of over +/-10% straining electrical components.

The ET enables the transit system to be more efficient and reduce energy usage and fluctuation. The team combined new and proven technologies into a well-integrated, efficient energy management system. The objective was to use renewable energy from solar panels to supply the monorail's on-board battery and Ucap storage system. Once the low power emitting solar energy was successfully captured it could remain in the Ucap storage unit for a very long time. Per their specifications the Maxwell Ultracapacitors uses will lose less than 1% of the stored power over a 24 hour period.

Traction current is carried through rails of suitable cross section fixed on both sides of the track beams. The traction voltage will be 750 V. D.C (+ 375V and – 375V). Two receiving sub stations have been proposed one in the car Depot and the other in the station in ground space. They will be of 2 x115 MVA capacities each. Traction sub stations have been proposed at 4 stations viz. Each station shall be provided with an independent Auxiliary Sub Station (ASS) to meet the power requirements of lighting, ventilation, air conditioning, for operation of lifts and escalators etc. . Stand by diesel generating sets of 100 KVA to 125 KVA capacities will also be installed as a standby arrangement to cater for emergency requirements.

Electric Power Tariff (Net Metering system)

The cost of electricity is a significant part of operation & maintenance (O&M) charges of the Two-tier Maglev Monorail system, which constitutes about 10-15% of total annual working cost for only the Auxillary Sub Station (ASS). The project makes use of the AC current supplied by the PEB (Puducherry Electricity Board) only for the electrical utilities at each and every station premises. This is expected to be in the range of Rs. 3.50 – 4.00 per unit (This rate is also applicable at "The Delhi Metro". The excess power that the Maglev Monorail system produces is exchanged with the PEB. All the stations have the **Net Metering facility**.

Ticketing and fare structure

Puduvai Trans Maglev Magnetic Two-tier Monorail Systems handle large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the

System. To achieve this objective, ticketing system shall be simple, easy to use/operate and maintain, easy on accounting facilities, capable of issuing single/multiple journey tickets, amenable for quick fare changes and require overall lesser manpower. In view of above, computer based automatic fare collection system is proposed. For Multiple Journey, the Store Value Smart Card shall be utilized and for the Single Journey, the media shall be Contactless Smart Token. AFC system proves to be cheaper than manual system in the long run due to reduced manpower cost for ticketing staff, reduced maintenance in comparison to paper ticket machines, overall less cost of recyclable tickets (Smart Card) in comparison to paper tickets and prevention of leakage of revenue. The AFC equipment shall be provided at each station at convenient locations and will be connected to a local area network with a computer in the Station Master's room.

Proposed fare structure for adoption in the year 2018 has been arrived at based on the existing bus fares (increased by about 1.5 to 2 times) and comparing with the fares adopted on the Delhi Metro Rail system. The initial fares to be adopted are indicated below:-

Distance in Kms	Fare in 2018-19 (Rs.)
0.2	10.00
2-4	12.00
4-6	15.00
6-9	18.00
9-12	20.00
12-15	22.00

The following sections highlight the objectives of the station, including the urban design objectives. It also describes the architectural vision, site planning issues, opportunities and constraints, and station design.

Entrances

Station entrances will be located with particular reference to passenger catchment points and physical site constraints within the right of way allocated to the station**.** Integrated entrances

- provide highly visible station entrances and address,
- station entrances relate to existing pedestrian networks and nodes, to maximize connectivity,
- station entrance planning is sympathetic with existing urban context heritage structures and landscape element,
- Station Planning,
- station planning focuses on connecting with and enhancing the existing public domain,
- station planning facilitates future opportunities for connections with adjacent landowners,
- station planning to accommodate passenger forecast and incorporate flexibility for expansion,
- the concourse level planning provides direct and clear passenger flows with access to ticketing, station, public and retail facilities from passenger convenience and comfort,
- the design of the station layouts will serve and ensure passenger convenience, safety and comfort.

Station Accommodation

Office accommodation, operational areas and plant room space is required in the non-public areas at each station. Wherever possible, emergency generators, transformers, pump houses, cooling tower plants, and water sumps will be located at ground level, preferably in one area of the station site.

Station Environment

Customer ease of use will be a priority on a number of levels. The first level concerns the ability of the public to easily locate and access the station, including the wider precinct area; this will sit comfortably in its local surroundings approaching the station indicating the entrance. Readily available information will be provided regarding services and amenities in the station environs. A simple way-finding policy will deliver signage that is clear, easy to read and caters for all modes of arrival at the station, a range of languages spoken (Tamil, English, Hindi) and impairments. Advertising, retail and non-essential signage will not impair way-finding. Customers with reduced mobility will be able to access and use the station independently through the provision of lifts. Access to stations outside the city centre will be provided for with a hierarchy of priority according to the sustainability of the access mode. This places pedestrian access first with cyclists and other public transport users next and finally Kiss and Ride/Taxi drop off. The seamless transfer between transport modes at interchanges is a key feature of the experience.

Station Ambience

The whole station environment will be attractive, welcoming, and easy to navigate and well maintained through the use of robust materials and the implementation of a station cleaning and maintenance regime that is regularly monitored and effectively managed. Building materials and finishes will be sustainability sourced wherever possible.

Efficient use will be made of resources such as water, electricity and natural light. In order to make the Monorail an attractive transport option over alternative modes, customers should be comfortable throughout the journey. The thermal conditions in the station will therefore be controlled so as to be comfortable for the majority of passengers. There should not be a severe temperature difference when stepping between the airs conditioned trains and the platforms, as it is large differences in temperature that particularly cause discomfort.

Crime risks will be mitigated by design including the provision of Ticket Gates to separate those who have business being from those who do not. All stations will be smoke-free supported by clear signage informing of the no smoking policy. There will be a zero-tolerance attitude to graffiti, meaning it will be removed from all stations (and trains) within 24 hrs. Those found guilty of applying graffiti will be prosecuted, as strong tactics will be required to overcome a problem that is endemic on other forms of public transport within PUDUCHERRY Community art will be facilitated in designated areas on ***Puduvai Trans*** property. Litter bins will be provided and

customers will be given the opportunity to recycle their rubbish through the use of separate bins. This will be subject to appropriate security measures such as transparent bins/bags and regular emptying. Waste storage areas will not be visible to customers, but will facilitate ease of collection.

The Station Experience

Shows the recommended alignment and stations

Stations will be staffed during operational hours with a presence on the concourse and on the platform. During non-operational hours the stations will be secured by shutters or similar devices, with access made available for maintenance and cleaning staff. During the early operational phase, a prominent staff presence on platforms is important for passenger safety perceptions especially while boarding and alighting from the train. Staff will be able to override automatic Platform Screen Doors if necessary and deal with door obstructions in the train. A staff presence on the platform supports passenger security and provision of information especially if there are service disruptions.

Staff presence on the concourse is important to deal with any problem with the ticket gates, and in deterring fare evasion. Staff will also be available to assist customers becoming accustomed to the automatic ticket machines. An important factor in the recruitment of staff will be attitude towards customer service. Staff skills and competencies will be further developed for customer service, conflict resolution and safety as well as in specific job skills. Staff will have the knowledge to deal with enquiries about local destinations and connecting transport services.

A clear Position Description will accompany each role and staff will have structured opportunities to contribute to continuous improvement as well as receive performance feedback. Equipment required to carry out tasks efficiently and effectively will be provided and well maintained. This will include use of modern technology such as Personal Digital Assistants to keep the staff up to date on operational issues and to enable them to communicate with ease.

A culture of pride in customer service will be nurtured from induction which will be informed by Customer Service Vision and Customer Service Statement and will be developed through customer engagement will be used at all stations. They will be interlocked with the train doors and have the capability to detect obstructions for customer safety. Furthermore they will:

- Be configured to authorize doors opening where a train is within +/-400mm of its specified stopping point
- Fully open all doors within 60 to 90 seconds of train coming to a standstill
- Be designed to be up to 800mm wider than the train doors where this is necessary to achieve train stopping accuracy
- Only open when a stopping passenger train can be positively detected on that platform
- Interface with the train so that the PSDs will only open when the train door open signal is detected
- Allow viewing of the upper part of the train by the use of glass panels. Clear labeling will be used to indicate where the wheelchair and stroller spaces are located on the train

- Provide a complete barrier to the platform edge, sealed sufficiently to prevent significant air movement
- Provide diagnostic information on a range of health conditions of the PSDs
- Have a control point situated near the platform for use by train or station staff in times of degraded operation or emergency

Security cameras, automated and manual Public Address and customer information screens will be provided, all of which will be compliant with the Disability Discrimination Act and other relevant legislation. Staff on platforms will have mobile access on that platform. Customer toilets will be provided within the paid area of the station. Retail facilities will be provided in the stations where there is limited access to other opportunities to purchase newspaper or refreshment in the surrounding area.

Access for All

One of the unique features of this system is that the entire route will be fully accessible, enabling mobility impaired customers to travel independently if they so wish or to be provided with assistances required. This will be reflected in the Disabled People's Protection Strategy together with provisions for other customers with special needs

The following Special Facilities will also be provided

- Clearly labeled wheelchair positions inside each train,
- Dedicated train boarding areas for the access and egress of wheelchairs,
- Wide gates, capable of self-closing with an electrically operated release, installed in the ticket barrier between the paid and un-paid areas,
- Priority seating on platforms,
- Customer Information Screens for hearing impaired passengers,
- Escalator audible devices for indicating the location of escalators,
- Passenger lifts with tactile landing buttons, handrails, and voice announcements.

Customer Information

The provision of accurate, high quality and simple to understand information is one of the most basic requirements for customers, especially during times of disruption and is a key issue that can determine the perceived quality of the customer experience. It will therefore be a priority for the Maglev Monorail to provide:

- Clear, visible and audible train running information on entry to the Monorail and on platforms, which provides a countdown to the next 3 trains,
- A general statement of the performance of the network that day and running information for other services at interchange locations,
- A consistent quality of customer information even during periods of degraded service when manual announcements may be required,
- Accessible help-points to enable customers to contact staff in an emergency or to obtain train running information,
- Customer Service staff that are well informed and 'happy to help', and
- The majority of customer information will be automated. Standards will be set for the

provision of information, announcements and printed information to ensure clarity and consistency.

Ticketing, Fares and Revenue Protection

The **Puduvai Trans** will be gated and therefore all customers will be required to purchase a valid ticket to enter and exit the system, simplifying the revenue protection policy.

Other Station Facilities

A combination of all substation lifts, main station only escalators and stairs will be provided stations to cater for the needs of all users. Temperature and other conditions will be made comfortable for passengers in the station and on platforms. Seating will be provided on all platforms with a dedicated area for priority seating, so the staff can easily identify those customers that will need assistance. Designated boarding points for wheelchair users will also be clearly marked. Customer toilets in the paid will be made available at all times during the hours of operation and will include baby change facilities and disabled facilities. They will be clean and odorless and monitored by the staff on a regular basis. A number of the stations are located within easy reach of large retail facilities and so the provision of retail outlets within the station precincts needs to be appropriate to the local situation. Providing a basic level of retail services is seen as part of the customer service that the **Puduvai Trans** offers passengers, and the revenue that such retail can generate is an important consideration.

The safety measures for the customers, employees, to the working system are separately dealt in the sub-heading – safety and security of sytems.

Station Services

Illumination

The illumination level shall conform to Indian & International standards. Wherever traffic integration areas are provided on the station premises of Suspended Monorail system, outdoor illumination either through poles or high masts, as appropriate, shall be provided.

Elevators

Lifts for use by passengers specially for differently able persons shall be provided as planned. As per norms adopted elevator will be required to be provided at the stations from ground to concourse and concourse to platform, the AFC gates to be planned accordingly.

Water Supply & Pumping

Stations shall be provided with water supply for washing as well as for fire protection measures. Water supply & pumping services shall be provided.

Ventilation & Air-conditioning

Elevated stations shall have normal ceiling fans and illumination for operational needs. VRV / VRF air-conditioning for signal and telecom and AFC equipment shall be provided according to need. The ECS (Environment control system) shall include the ventilation by exhaust fans of plant rooms and toilets etc.

Power Supply for Signals

The primary source of power supply for signaling and telecommunication will be MAGLEV Two-tier Monorail Authorities 33 kV/415-volt 3-phase dc power distribution system.

Standby Diesel Generator (Dg) Sets

In the unlikely event of simultaneous tripping of all the RSSs or grid failure, the power supply to stations as well as to trains will be interrupted. It is, therefore, proposed to provide standby DG set of 100KVA to 125KVA capacity at elevated/at-grade stations and 500 KVA capacity for Depot to cater the following essential services:-

- Lift operation,
- Essential lighting,
- Signaling & telecommunications,
- Fire fighting system.

Silent types of DG sets are proposed which have low noise levels and do not require separate room for installation.

The entire system of power supply (receiving, traction & auxiliary supply) shall be monitored and controlled from a centralized Operation Control Centre (OCC) through SCADA system being provided at Maintenance Depot near Puducherry University. Modern SCADA system with intelligent remote terminal units (RTUs) shall be provided. Optical fiber provided for telecommunications will be used as communication carrier for SCADA system.

Digital Protection Control System (DPCS) is proposed for providing data acquisition, data processing, overall protection control, interlocking, inter-tripping and monitoring of the entire power supply system consisting of 66/33kV&110/33KV ac switchgear, transformers, 750V dc switchgear and associated electrical equipment. DPCS will utilize microprocessor-based fast-acting numerical relays & Programmable Logic Controllers (PLCs) with suitable interface with SCADA system.

General Criteria

Certain general criteria for finish materials are indicated below to achieve the goals outlined above as well as those, which would result in a high level of illumination, good cleanliness levels, and the appearance of high cleanliness.

Surface

Applied materials shall be hard, dense, non-porous, non-staining, acid and alkali resistant, of long life and low maintenance. Surfaces within reach of the public, up to 3 m above the floor level may be finished with applied materials.

Color

Colors shall aid maintaining high illumination levels, with sufficient contrasts and accents to provide visual interest and warmth and to conceal minor soiling.

Texture
Smooth surfaces should be preferred over rough ones for ease in cleaning and being less prone to catch settling dust. Rough surfaces are desirable where a skid resistant feature is important, and are acceptable where surfaces are difficult to reach. A distinctive texture shall be provided at the platform edge when open or operable to the tracking to enable the blind to sense the platform edge.

Unit Size
Unit should be large enough to reduce the number of joints yet small enough to conceal minor soiling and scratches and to facilitate replacement if damaged. Monolithic materials may be used if they have inherent soil hiding characteristics that can be easily repaired without the repair being noticeable.

Joints
Joints should be small, flush, limited in number and using the best possible materials. Horizontal joints should not be raked but should be flush or tooled concave. Monolithic materials should have adequate control joints and expansion joints at the proper spacing in order to prevent surface cracking.

Cost
Materials shall be selected for long life, low maintenance, easy to replace and overall aesthetic and functional qualities.

Availability
Materials selected should be readily available. Domestic products shall be selected unless the product is not available within the country.

Proprietary Materials
Proprietary items shall only be used where it is established that no other materials would meet the particular design requirements.

Installation Standards
Materials shall be detailed and specified to be installed in accordance with industry standards and manufacturer's printed directions.

Flammability
- Interior finishes including doors/ windows shall meet requirements of the code and the fire/life safety requirement,
- Finishes for all protected exit ways shall be Class A as defined by NFPA 101. Corridors,
- stairways, and vestibules shall be considered exit ways,
- finishes in all other areas shall be Class B as defined by NFPA 101, and
- Combustible adhesives and sealants may be used when they meet the requirements stated above.

Basic Requirements Safety

Fire Resistance and Smoke Generation Use materials with minimum burning rates, smoke generation, and with less toxicity characteristics.

Fire/Life Safety requirements

- Eliminate hazard from dislodgment due to temperature change, vibration, wind, seismic forces, aging, or other causes, by using proper attachments of adequate bond strength.
- Skid-resistant (for walking surfaces) Use floor materials with skid-resistant qualities. Entrances, stairways, platform edge strips, and areas around equipment should have flooring having high skid-resistant properties.
- The following static coefficients of friction shall be provided as a minimum,
- Coefficient of Friction ,
- Public horizontal surfaces-0.6,
- non-public horizontal surfaces, interior-0.5,
- non-public horizontal surfaces, exterior-0.6,
- stairs, ramps, sloping sidewalks-0.8, and
- Area around equipment-0.6.

Durability

Use materials with wear resistance, strength, and weathering qualities consistent with their initial and replacement costs, and their location in the Station. The materials must maintain good appearance throughout their useful life. Materials shall be colorfast.

Ease of Maintenance and Cleaning

Use materials which do not soil or stain easily, which have surfaces that are easy to clean in a single operation, and on which minor soiling is not apparent. Materials shall be cleanable with standard equipment and cleansing agents.

Repair or Replacement

Use materials which, if damaged, are easily repaired or replaced without undue interference with the operation of the System. Spare materials shall be available for tile and other unit materials. (Say a quantity of approximately two percent of the total used.).

Aesthetic Qualities

Create feeling of warmth, attractiveness, quality, and civic pride in the facility.

CCTV

Rolling stock and infrastructure condition monitoring and alarm systems.

British Standards (BS)

American Architectural Manufacturers Association (AAMA).

NFPA Codes

Landscaping at Elevated Station Complex and Guideway Alignment
Landscaping of all areas within the Rail System shall be undertaken in consultation with the Government.

Rail Car System Alignment

- Suitable landscaping and appropriate vegetation along the route of the viaduct shall be provided to improve the aesthetic appearance.
- Shrubs, trees and ground cover suitable to their location and the city environment shall be provided within the full length of the central median to improve and soften the impact of the structure on the city scene after completion of construction.
- Watering points shall be provided at appropriate centers along the median.

Facilities in and around Station Areas

Appropriate planting should be provided to enhance and soften the appearance of the Station box, the approach structures and the inter change areas.

Rain Water Harvesting

The rain water harvesting of the runoff water within the Station areas shall be planned as per the policy, rules, norms, requirements and methods of the State and the Central Government.

Fencing

The Concessionaire shall provide appropriate vandal-proof perimeter fencing at suitable locations, determined in consultation with the IE, along the entire reserve boundaries at both sides of the Rail System including Depots, Stations, installations, buildings etc.

Environmental Protection Requirements

The Concessionaire shall implement the environmental protection requirements applicable to the Works.

Noise

- The design of the permanent works shall comply fully with the following requirements:
- All parts, including non-structural parts, of the structures shall minimize as far as practicable the radiation of noise due to vibration caused by the passage of Trains. Particular attention shall be paid to the minimization of noise at the low end of the acoustic frequency spectrum,
- Walls and slabs intended to contain airborne noise from the Trains shall be of concrete of 200 mm minimum thickness and shall be purpose-made, non-combustible and vibration absorbing / dampening, and shall utilize GRC panels or similar construction.
- Allowable Range of Noise levels:
- The allowable range of noise levels for different land uses are:
  Residential: 50 – 70 dbA
  Business and Commercial: 75 dbA
  Hospitals: 60 dbA

Rural:45 – 50 dbA

Provision of Noise barriers

Noise shall be reduced to locally acceptable levels by provision of low vibration track forms, resilient base plates, design of parapet walls and treatment of their track side surface. They shall be supplemented by providing sound absorption material on sides of the viaduct superstructures. Additional noise barriers shall be provided in lengths of viaducts and bridges passing through sensitive residential or hospital zones. The choice of barrier type and their disposition along the parapet / railing shall be closely related to aesthetics of the structures.

Accommodating Structures

The welded steel or reinforced concrete guideway beams way for geometric design, general features specifications and requirements for accommodating structures forming part of the ***Puduvai Trans*****,**

- The horizontal and vertical alignments of the shown in the DPR are for general guidance purpose. The Concessionaire shall design the engineering works to these alignments in general. However, minor changes to the given alignments may be made in consultation with the IE.
- Accommodating structures include all Structures/Buildings and E&Ms required for properly sheltering the Rail System including the maintenance equipment, Users and staff, and shall satisfy the following conditions:
- Rail System shall function in accordance with the requirements specified.
- Staff shall fulfill their duties as per the operation plans in safe, healthy and efficient Conditions.
- The User flow can circulate in safe and comfortable manner even in case of Emergency.
- The accommodating structures shall allow the above mentioned functions for all operating Conditions.

Accommodating structures shall include, inter alia, the following:

- Elevated guideway or viaduct.
- Bridges.
- Stations and auxiliary buildings.
- Depot area and buildings for maintenance facility.
- Other buildings/structures required for operation and maintenance.

Architecture

The structures shall be aesthetically pleasing, sleek and be environment friendly, maximizing use of pre-cast structural elements.

Passage for Emergency Evacuation of Users

A passage of width not less than 700 mm with safety railing shall be provided on each side of the double track all along the elevated corridor to facilitate evacuation of Users during Emergency.

Cable Ducts
Provision shall be made in the design of the deck for ducts for laying electrical, signaling and telecom cables.

Felling of trees
Felling of trees shall be done only with the approval of the concerned authorities, and in compliance with all Applicable Laws.

Access Roads
Construction of access road for vehicles, plant and machineries to approach the Site shall be with the approval of the concerned authorities.

Drainage Arrangements
Properly designed drainage scheme for the elevated guideway structure, Stations and concourse and Depot shall be provided. All drains shall be of adequate size as per hydraulic calculations and shall be connected to the nearest underground drainage facilities or discharge facilities with the provision of sumps, man holes, cross drains etc. For fast track construction, use of pre-cast RCC standardized drain sections shall be adopted.

- Precaution against Flooding,
- Mitigating measures shall be taken in areas where flooding is likely to occur,
- Environmental Quality,
- The requirements of Environmental quality as per regulations shall be met,
- Elevated welded steel reinforced concrete guideway beams Structure – Features,
- Choice of Superstructure,
- The choice of superstructure shall be made keeping in view the ease of construction, fast track work and maximum standardization,
- Following types of superstructure are generally in use in India,
- Pre-cast segmental box girder using external un-bonded tendons, and
- steel/concrete composite girders.

Any other type of superstructure found more suitable and appropriate for the site condition may also be adopted. In situ construction is not acceptable unless absolutely necessary in specific locations as reviewed by the IE.

Sub-structure/Foundation
Open or pile foundations may be adopted depending on the suitability of soil strata encountered. The pile cap/open foundation top shall be kept at least 500 mm below the road level so as to facilitate necessary drainage from the viaduct and crossing of utilities. For Rail bridges, foundation design shall take into account scour conditions in the river bed. For construction of pile foundations, rotary hydraulic drilling rigs with faster productivity shall be used.

Deck Drainage and Waterproofing
RCC surface drains at deck level shall be constructed along the viaduct route. Runoff shall be collected through surface drains that shall lead to down drains at the designated support columns

and connected to a suitable drainage system. Provision for silt removal shall be made where necessary. All metallic components of the drainage system shall be seam welded for water tightness and given two coats of bituminous painting before placement. The whole assembly shall be placed in true position, line and level and held in place firmly.

Roadway width during construction

As most of the construction is to be carried out on the middle of the road, central two lanes including median will be required for construction activities. During piling and / or open foundation work, a width of maximum 8 m will be reserved for construction and the same shall be barricaded. It is essential that at least two lanes are always provided for traffic on either side of barricade during construction by widening of roads, if necessary. If site conditions do not permit the same, one way traffic may be resorted to in co-ordination with the traffic authorities. A detailed traffic management plan shall be prepared for each stretch of the route in consultation with the IE and shall be complied with.

Barricades during construction and work site protection.

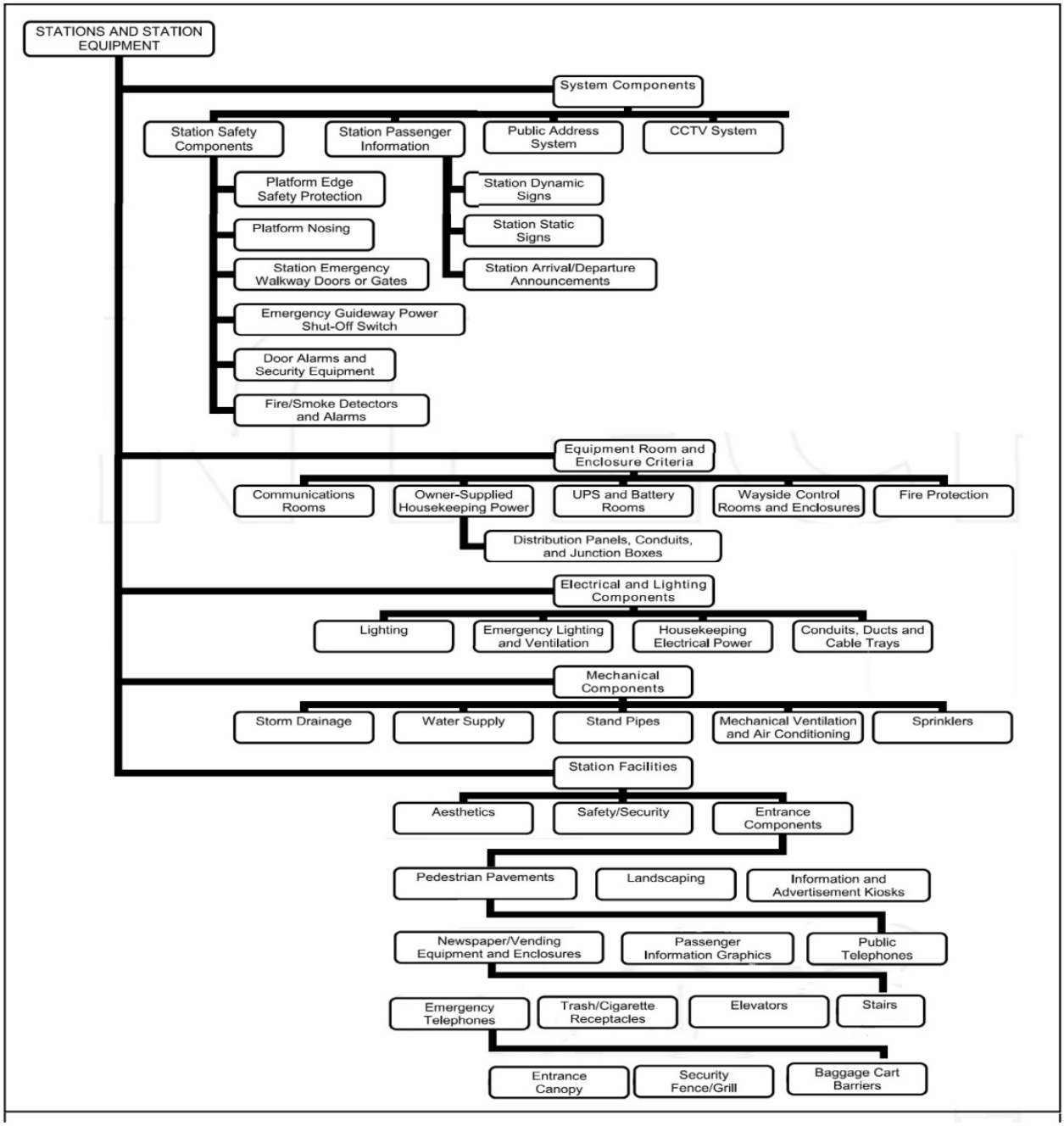
- Barricades shall be erected and work site protected as per Specifications and Standards furnished.
- Housekeeping and Safety management at sites.
- Housekeeping of construction sites shall be professionally organized to render a neat and safe appearance at the sites. Suitable gaps (with lockable gates wherever feasible) in barricading shall be provided at planned locations to facilitate.
- Movement of cross traffic at junctions.
- Movement of construction materials and
- Security posts location.

The Concessionaire shall keep and maintain a well designed and detailed Safety Manual to be adopted at all his construction sites. Safety issues shall be given highest importance during construction. Third party safety audits shall be conducted at maximum six months intervals at sites. Necessary insurance policies (viz. comprehensive all risk insurance) shall be taken before start of site activities. Safety meetings shall be held at regular intervals with all stakeholders and state traffic police department.

Other civil works as required for proper functioning of the Rail System
Performance requirement

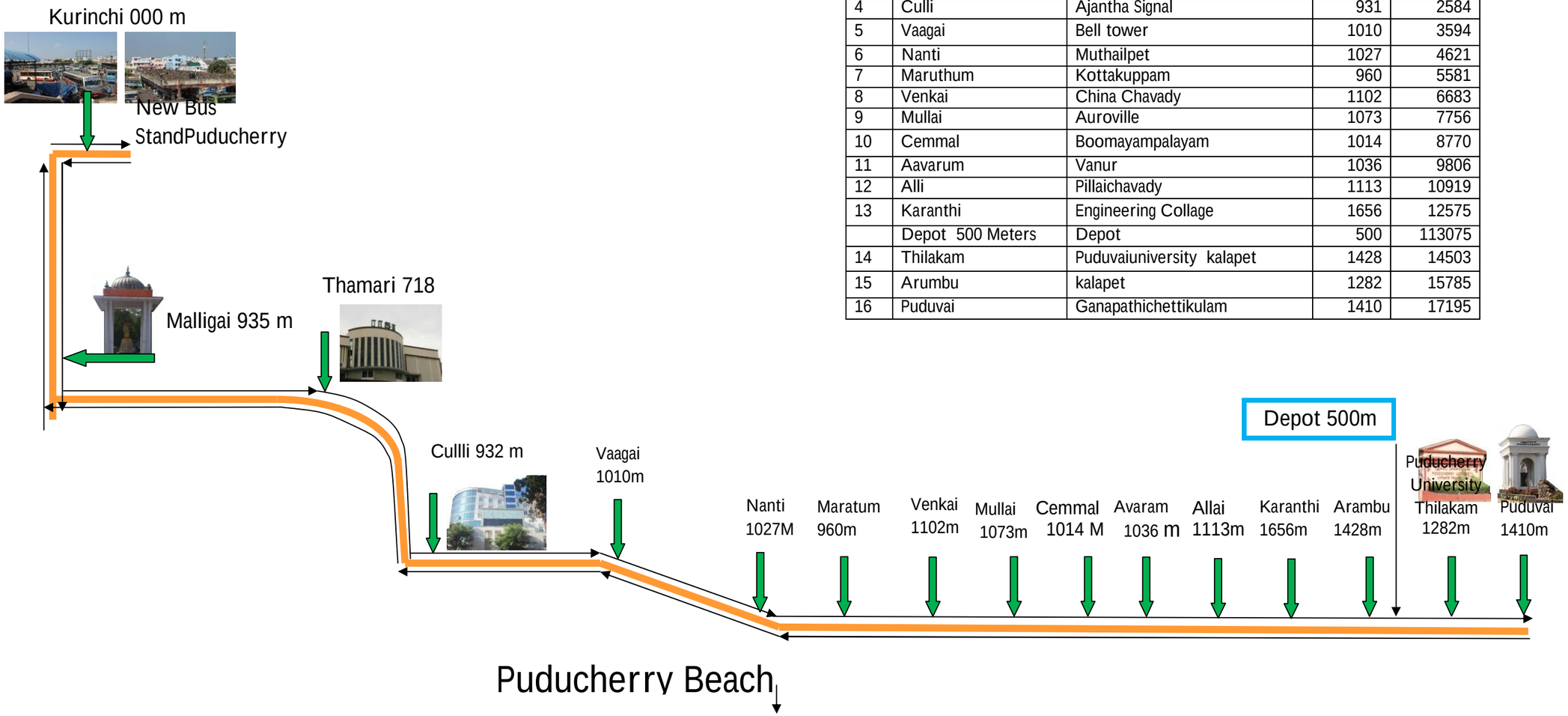
- All permanent and temporary civil works construction shall satisfy the major requirements of existing traffic flow.
- Normal traffic flow on the existing road at ground level shall not be disturbed until alternate and satisfactory arrangements are provided.
- Generally, no ground scaffold shall be erected for construction of superstructure. In portions where pre-cast superstructure may not be feasible, the scaffold system shall provide required horizontal and vertical clearances for the moving traffic at ground level as per guidelines of IRC.

Station Plan

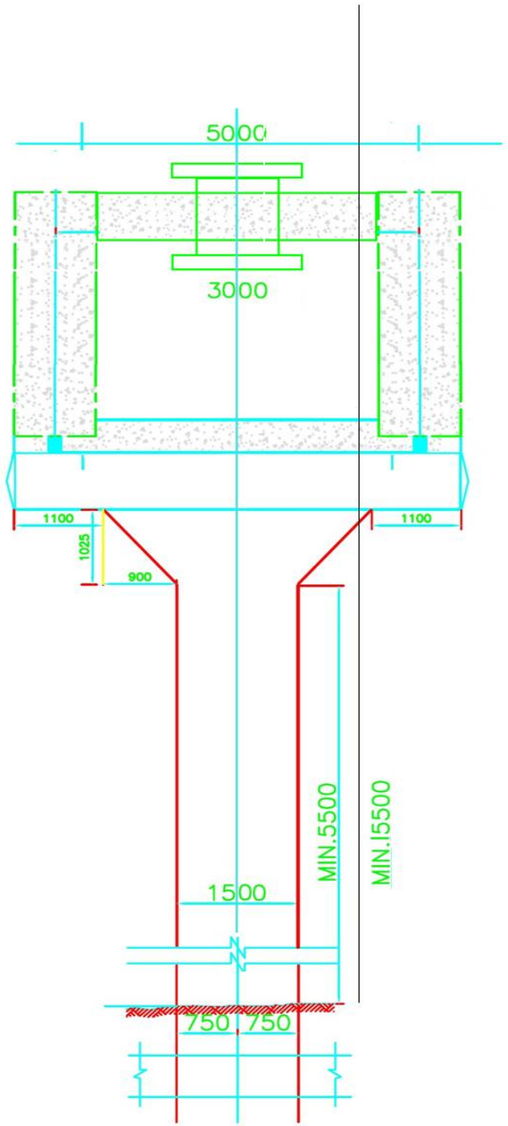


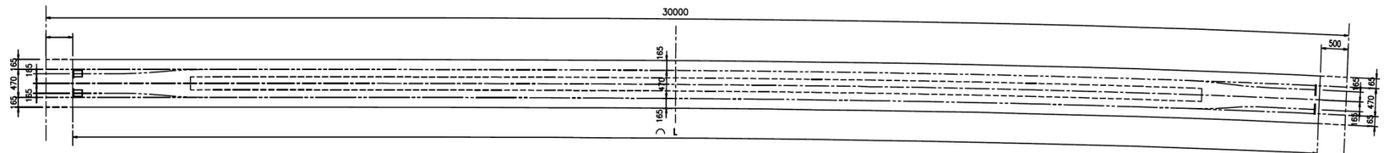
STATION SYSTEMATIC PLAN

Puduvai Trans Rapid System
Station Location Route Measurement Plan

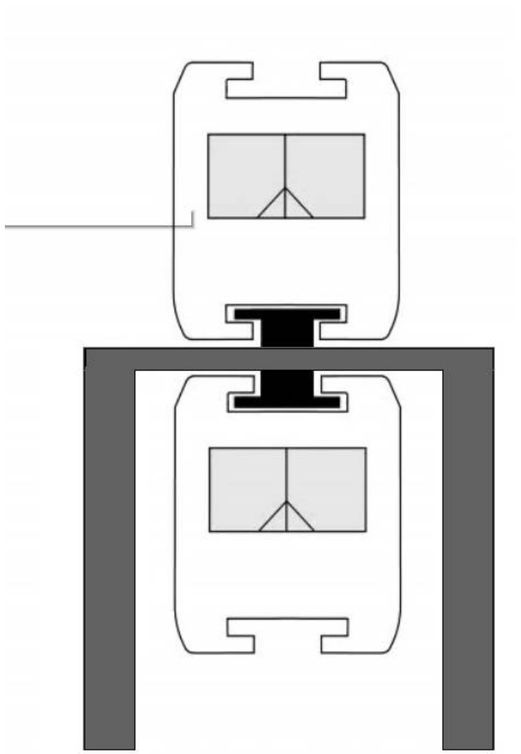


Puduvai Trans Route Plan And Station Location Measurement				
No	Station Names	Area Names	Length	Chainage
1	Kurinchi	New Bus Stand	0.00	0.00
2	Malligai	Botanical Garden	935	935
3	Thamarai	Raja Theatre	718	1653
4	Culli	Ajantha Signal	931	2584
5	Vaagai	Bell tower	1010	3594
6	Nanti	Muthailpet	1027	4621
7	Maruthum	Kottakuppam	960	5581
8	Venkai	China Chavady	1102	6683
9	Mullai	Auroville	1073	7756
10	Cemmal	Boomayampalayam	1014	8770
11	Aavarum	Vanur	1036	9806
12	Alli	Pillaichavady	1113	10919
13	Karanthi	Engineering Collage	1656	12575
	Depot 500 Meters	Depot	500	113075
14	Thilakam	Puduvaiuniversity kalapet	1428	14503
15	Arumbu	kalapet	1282	15785
16	Puduvai	Ganapathichettikulam	1410	17195



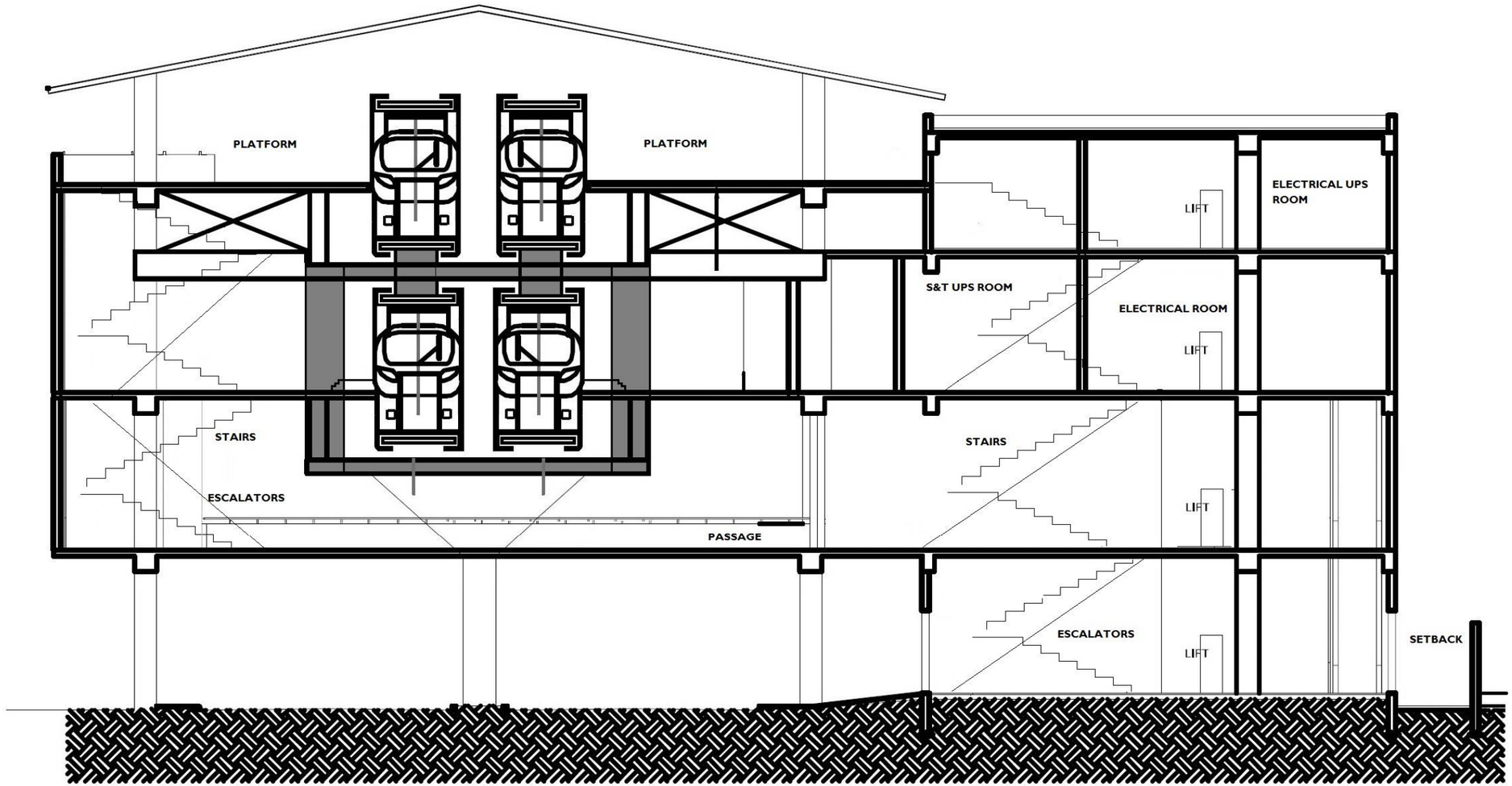


Concrete Magnetic Guidway 30 meter

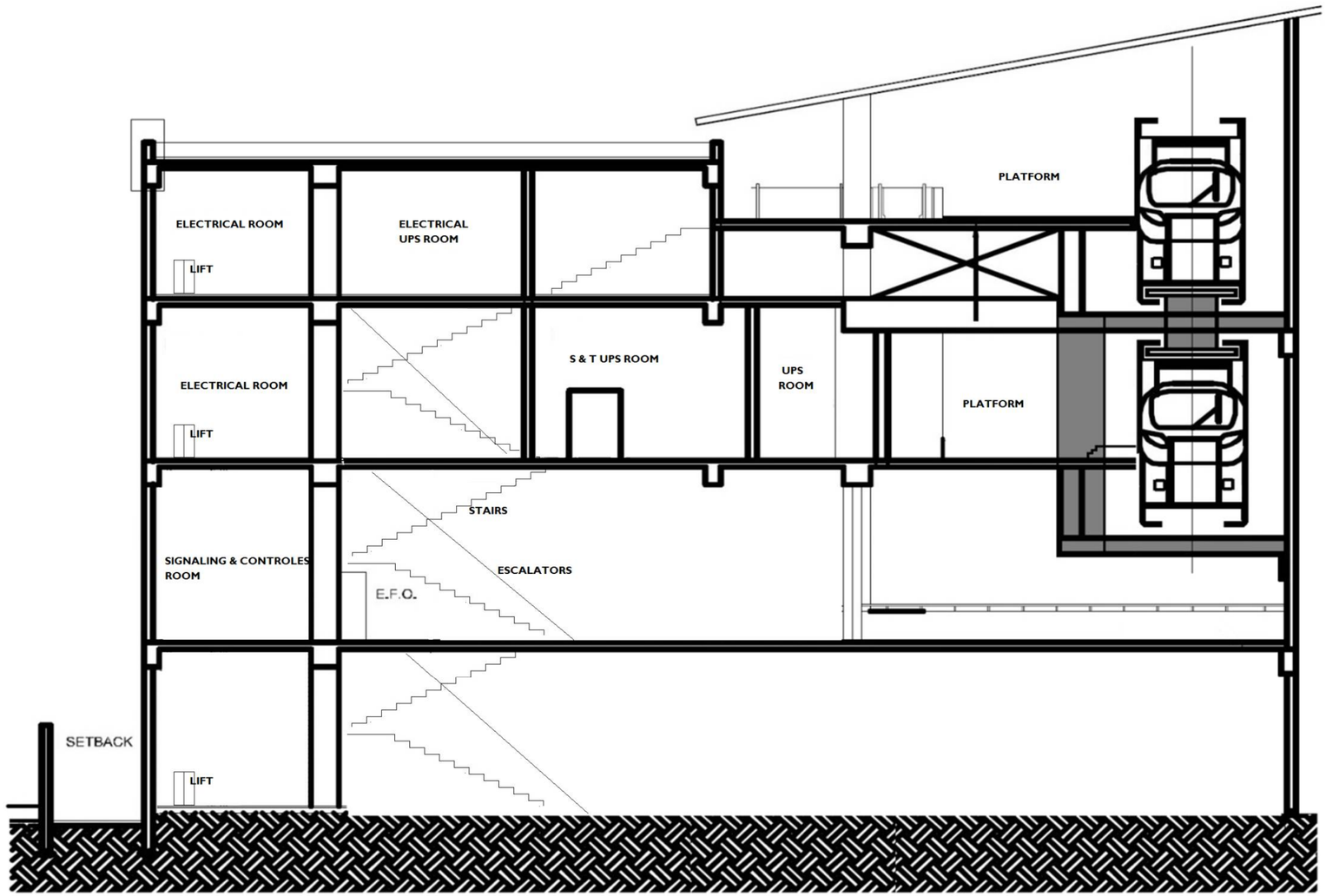


New Two-tier Maglev-System

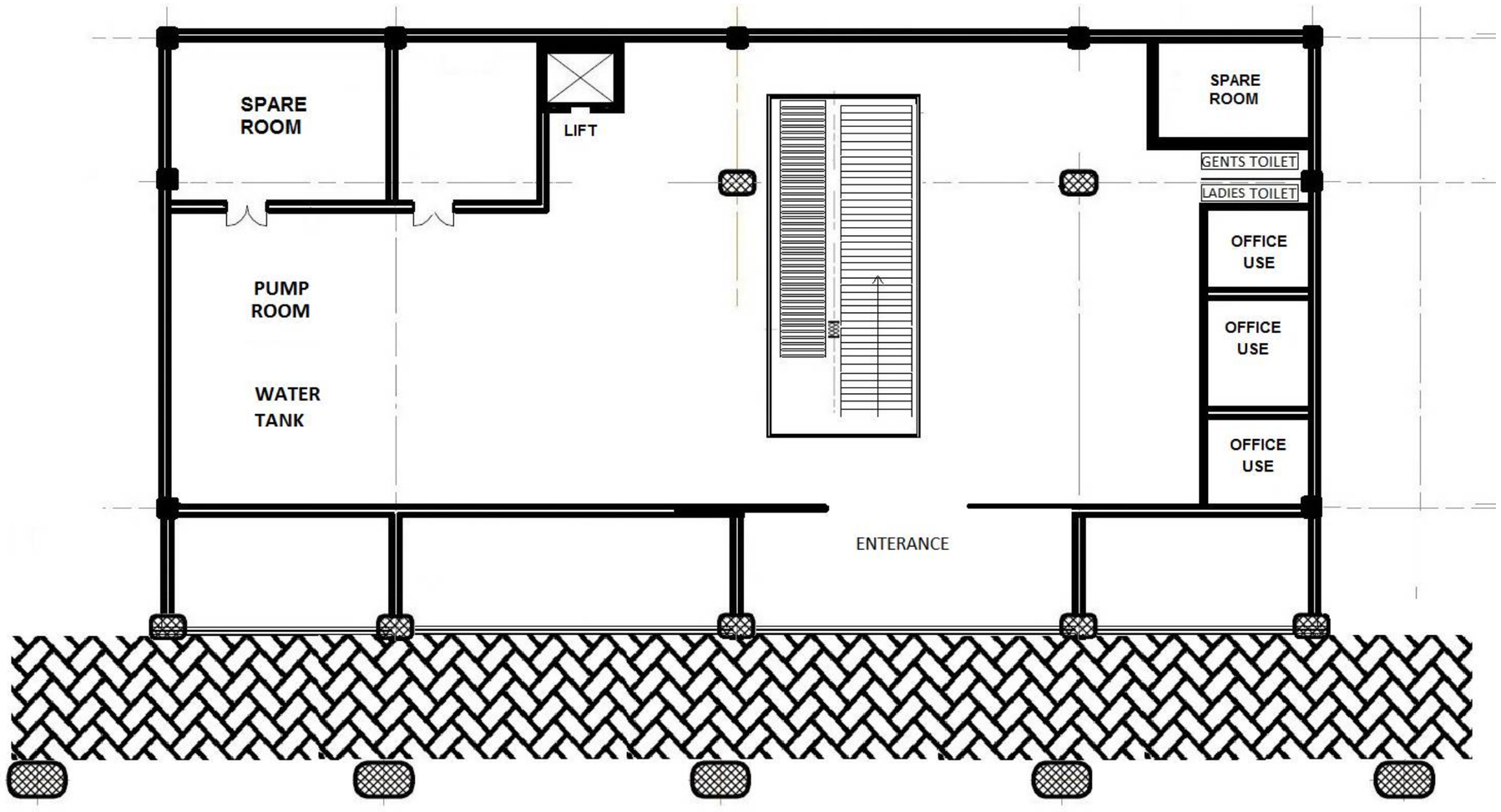
All Dimension Are In Millimeters All Dimensions Are To Be Read and Not Measured Any Discrepancies Must Be brought to the notice architect before executions of work at site	Pudhuvai Trans Rapid System Main Pillar	PUDUVAI TRANS RAPID SYSTEM			
		Main Pillar Plan			
		Drawing number	Scale nts	Date	Sheet size A-3



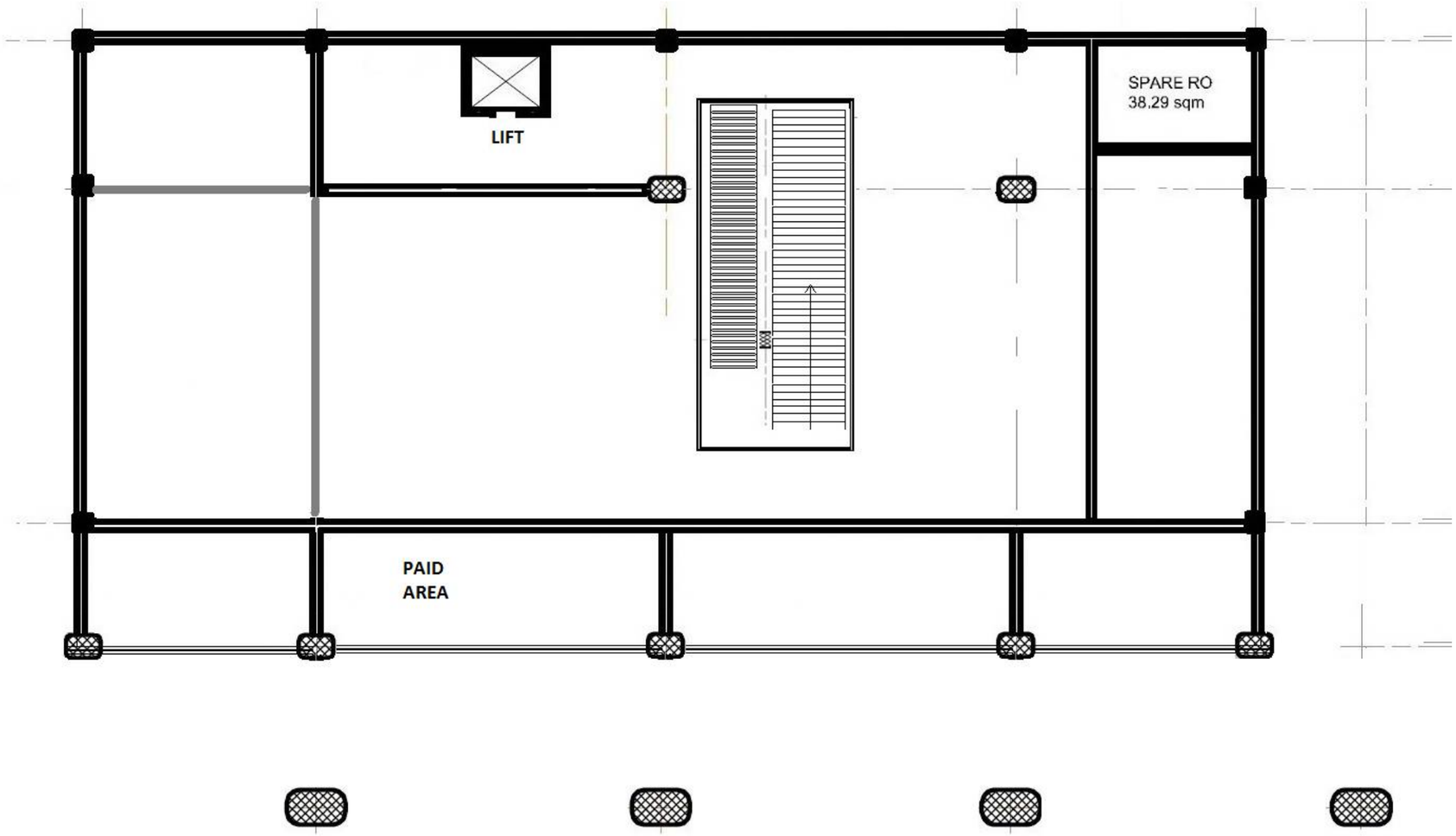
All Dimension Are In Millimeters All Dimensions Are To Be Read and Not Measured Any Discrepancies Must Be brought to the notice architect before executions of work at site	Puduvai Trans Main Station Plan	PUDUVAI TRANS RAPID SYSTEM			
		TYPE-A			
		Drawing number	Scale NTS	Date	Sheet size A-3



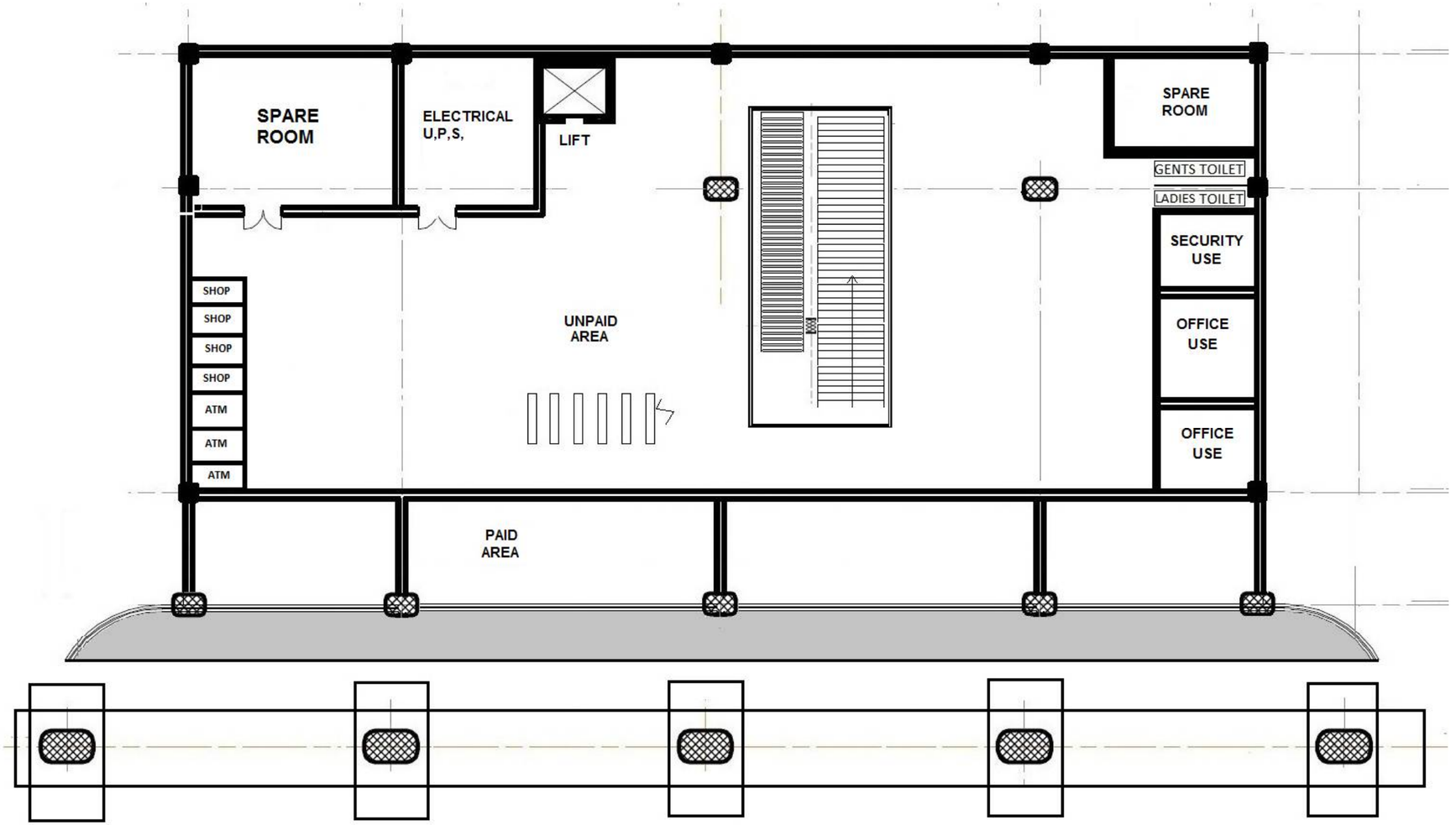
All Dimension Are In Millimeters All Dimensions Are To Be Read and Not Measured Any Discrepancies Must Be brought to the notice architect before executions of work at site	Puduvai Trans Station Plan	PUDUVAI TRANS RAPID SYSTEM			
		TYPE-B			
		Drawing number	Scale NTS	Date	Sheet size A-3



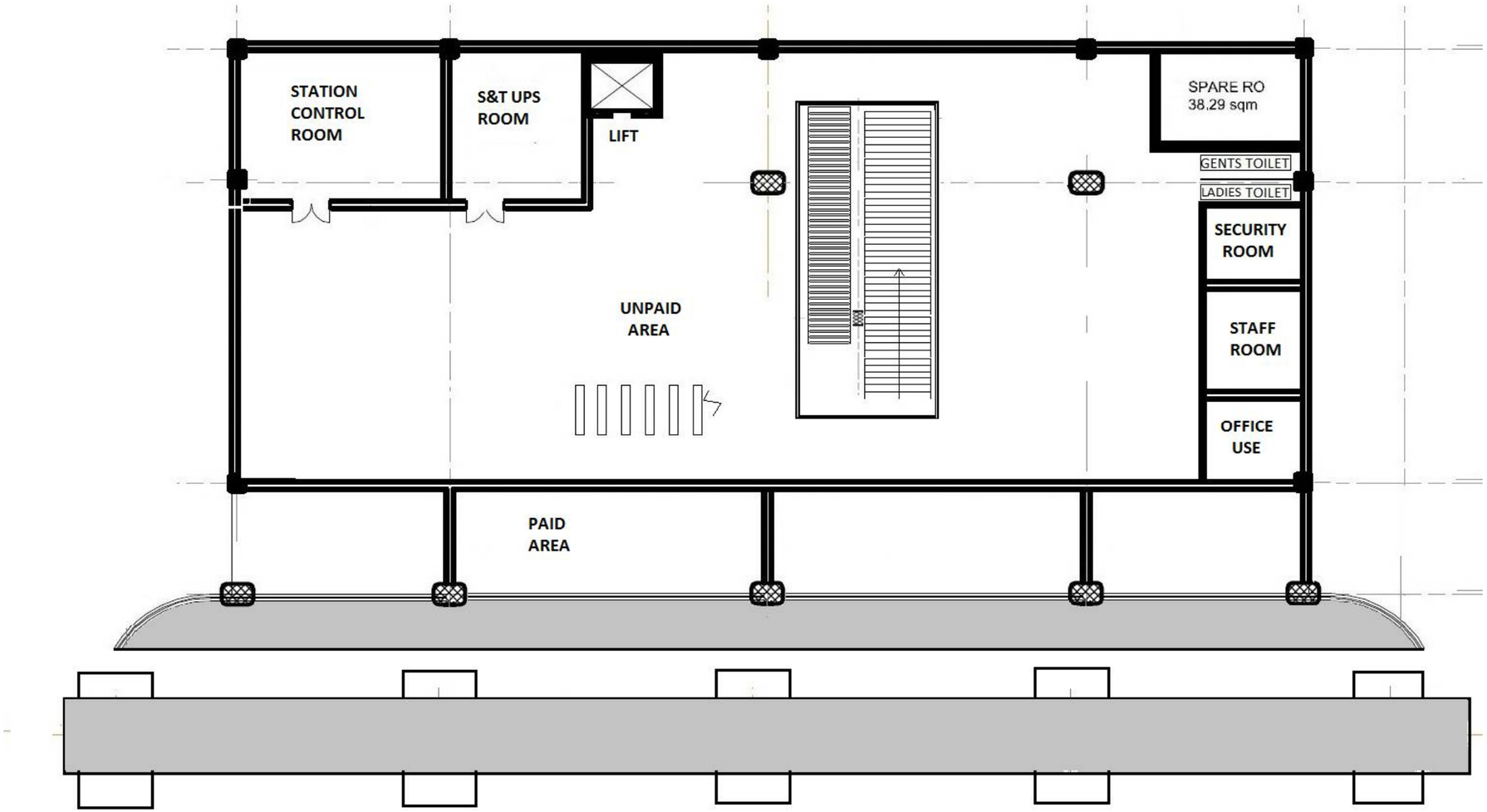
All Dimension Are In Millimeters All Dimensions Are To Be Read and Not Measured Any Discrepancies Must Be brought to the notice architect before executions of work at site	Puduvai Trans Station Ground Floor Plan	PUDUVAI TRANS RAPID SYSTEM			
		Ground Floor plan Type-B			
		Drawing number	Scale nts	Date	Sheet size A-3



All Dimension Are In Millimeters All Dimensions Are To Be Read and Not Measured Any Discrepancies Must Be brought to the notice architect before executions of work at site	Puduvai Trans Station First Floor Plan	PUDUVAI TRANS RAPID SYSTEM			
		First Floor Plan Type-B			
		Drawing number	Scale NTS	Date	Sheet size A-3



All Dimension Are In Millimeters All Dimensions Are To Be Read and Not Measured Any Discrepancies Must Be brought to the notice architect before executions of work at site	Puduvai Trans Platform Level 1Plan	PUDUVAI TRANS RAPID SYSTEM			
		Platform Level 1Plan Type-B			
		Drawing number	Scale NTS	Date	Sheet size A-3

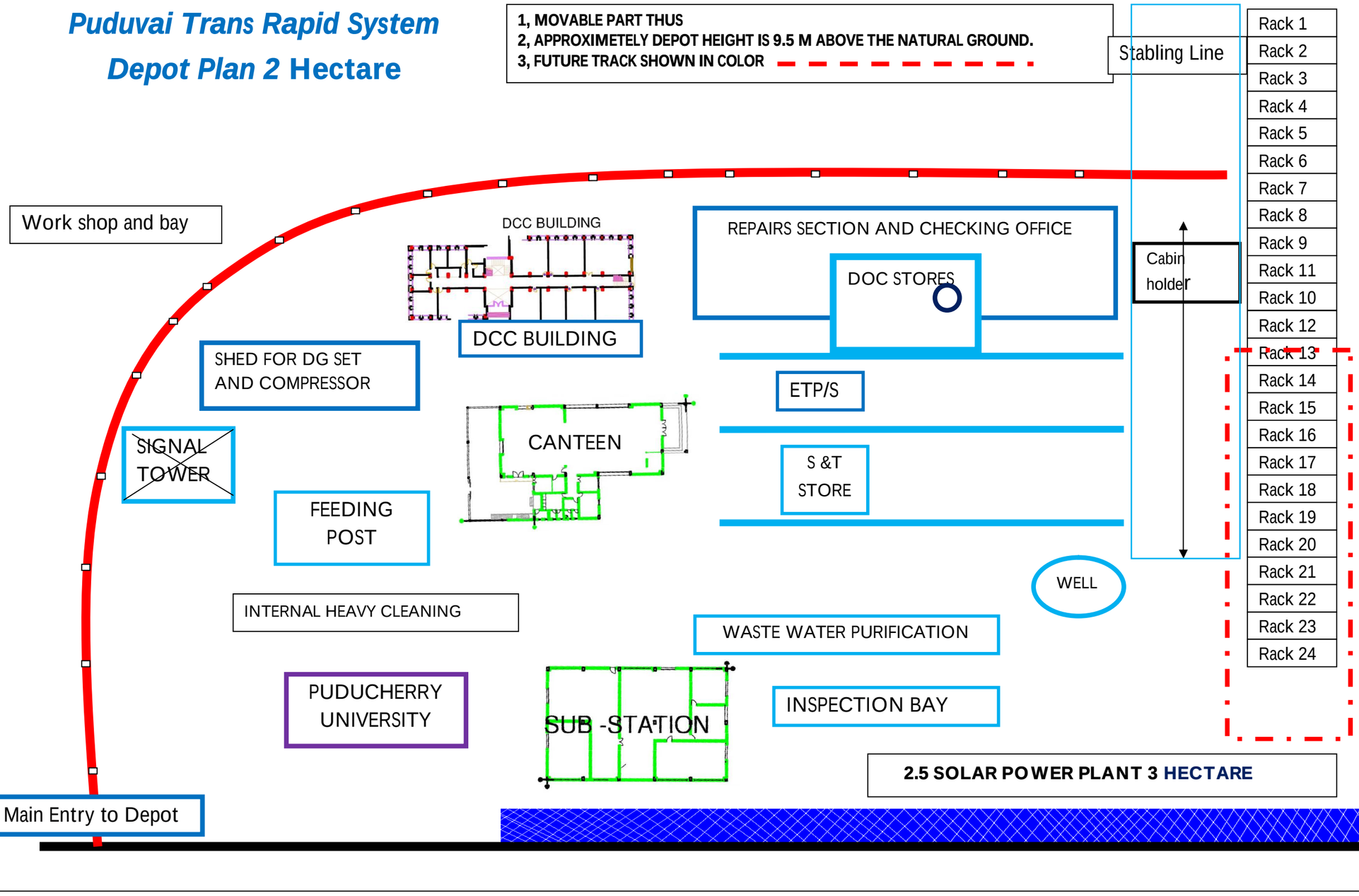


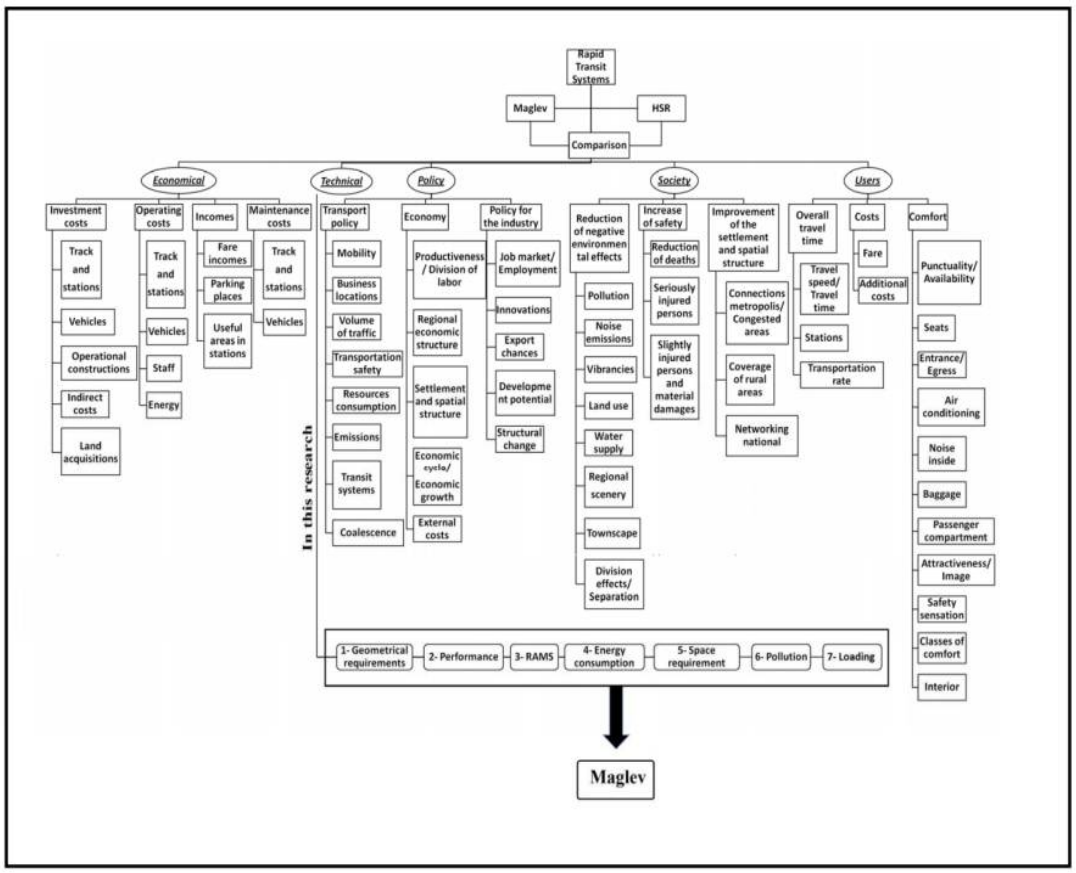
All Dimension Are In Millimeters All Dimensions Are To Be Read and Not Measured Any Discrepancies Must Be brought to the notice architect before executions of work at site	Puduvai Trans Station Platform 2 Plan	PUDUVAI TRANS RAPID SYSTEM			
		Station Platform 2 Plan Type-B			
		Drawing number	Scale NTS	Date	Sheet size A-3

Puduvai Trans Rapid System

Depot Plan 2 Hectare

1, MOVABLE PART THUS
2, APPROXIMETELY DEPOT HEIGHT IS 9.5 M ABOVE THE NATURAL GROUND.
3, FUTURE TRACK SHOWN IN COLOR




Rapid Transit Systems
Maglev
HSR
Comparison
Economical
Technical
Policy
Society
Users
Investment costs
Operating costs
Incomes
Maintenance costs
Transport policy
Economy
Policy for the industry
Reduction of negative environmental effects
Increase of safety
Improvement of the settlement and spatial structure
Overall travel time
Costs
Comfort
Track and stations
Vehicles
Operational constructions
Indirect costs
Land acquisitions
Staff
Energy
Fare incomes
Parking places
Useful areas in stations
Mobility
Business locations
Volume of traffic
Transportation safety
Resources consumption
Emissions
Transit systems
Coalescence
Productiveness / Division of labor
Regional economic structure
Settlement and spatial structure
Economic cycle/ Economic growth
External costs
Job market/ Employment
Innovations
Export chances
Developme nt potential
Structural change
Pollution
Noise emissions
Vibrancies
Land use
Water supply
Regional scenery
Townscape
Division effects/ Separation
Reduction of deaths
Seriously injured persons
Slightly injured persons and material damages
Connections metropolis/ Congested areas
Coverage of rural areas
Networking national
Travel speed/ Travel time
Stations
Transportation rate
Fare
Additional costs
Punctuality/ Availability
Seats
Entrance/ Egress
Air conditioning
Noise inside
Baggage
Passenger compartment
Attractiveness/ Image
Safety sensation
Classes of comfort
Interior
In this research
1- Geometrical requirements
2- Performance
3- RAMS
4- Energy consumption
5- Space requirement
6- Pollution
7- Loading
Maglev

9.13- Substations: Traction and Power Supply

Electronic control systems control the clearance (nominally 10 mm). The levitation system uses on-board batteries that are independent of the propulsion system. The vehicle is capable of hovering up to one hour without external energy. While travelling, the on-board batteries are recharged by linear generators integrated into the support magnets. A synchronous, long stator linear motor is used in the Trans rapid maglev system both for propulsion and braking. It functions like a rotating electric motor whose stator is cut open and stretched along under the guideway. Inside the motor windings, alternating current is generating a magnetic travelling field that moves the vehicle without contact. The support magnets in the vehicle function as the excitation portion (rotor). The speed can be continuously regulated by varying the frequency of the alternating current. If the direction of the travelling field is reversed, the motor becomes a generator which brakes the vehicle without any contact. In accordance with Lenz's Law, the interaction of the levitation field with the current in the slots of the rail results in propulsion or braking force. During the motion of the magnet along the rail, the linear generator winding of the main pole is coupled with a non-constant flux, which induces a voltage and reloads the on-board batteries. The generation process begins in the range of 15 km/h and equals the losses of the magnetic suspension systems at 90 km/h. The whole energy losses of the vehicle are compensated at a velocity of 110 km/h and the batteries are reloaded. Thus the levitation magnet integrates three tasks: levitation, propulsion and transfer of energy to the vehicle

The main requirements for a transportation system are:

- Length of Guideway,
- passenger capacity,
- travel time to destination,
- maximum waiting time for passengers at the stations.

Therefore the main design parameters for a transportation system are:

- alignment,
- comfort criteria,
- speed profiles,
- operation concept including headway times,
- availability, reliability.

Solar Powered

Solar powered railway transport more efficient the carriages must be designed light weight, while at the same time they must be stable at efficient speeds. In this context, the authors are working on stable track designs that would be able to support light weight high speed railway system. For this purpose, a case study is being undertaken on the prospects of launching such a system in a tropical metropolis the average solar insolation of about 525 W/m2. Taking a practical example of a light weight train, typically a light rail carriage with a design load of carrying 160 passengers is powered by one DC motor per power truck with typical dimensions. The aforementioned statistics warrant a serious research toward the designing, analysis and prototyping of a PV based light railway system. In this context, the authors are in

the process of launching the design and analysis phase of this project. This phase will involve detailed mechanical designing based on scaled down modeling, analysis and testing and evaluation. Once this phase has been completed, a full scale prototype will be developed and tested. Once this phase is successfully completed, the project can be launched on a commercial scale. A typical solar power railway station would be designed to receive maximum solar insulation. This depends on two major factors, firstly, orientation of the sun and secondly, the surroundings through which the train would pass, the movement of the sun from rising till setting is trending east-south in morning and west-north in the evening. The surrounding of the likely train route would have buildings of varying shapes and heights. This necessitate that solar railway building should be designed and oriented with slanting roofs and height of solar railway line is adjusted such that it receives maximum possible insulation throughout the day along the entire route. A suggested layout of the solar railway station ***Puduvai Trans*** features of a typical solar panel fully covered in station are: A longitudinal building which has maximum exposure to sun.

- Ground floor can be used for elevators and commercial activities.
- Roof will be used for solar paneling.
- Side walls of first floor will also be used be for solar paneling.
- Sides and roof of the train will be used for solar paneling.

The age of low cost fossil fuels is over and that warrants serious research into the development of alternate fuels.

• The transport sector consumes about 61.7% (approximately) of the world oil consumption while its contribution towards greenhouse emissions stands at 13.4 % (approximately).

• From the economic as well as environmental point of view, research towards the development of alternate energy options for the transport sector is deemed necessary.

• Railway transport can be considered the most energy efficient and environment friendly mode of transport.

• Since the sun is the largest source of energy on earth, this research presents a case to carry out research towards the development and commercialization a light weight solar railway system.

The total power generated by solar energy is around	2.5MW power.
Volts (Traction power)	750v dc.
Usage power for functioning the grid	110kV.
Auxiliary load	33 kV/ 750vDC
Main LT Panels	
Power For SCADA	25 kV
Stand-by diesel generator to feed the auxiliary loads in case of power failure from the main supply.	415volt DC
Auxiliary power for total no of stations (17 stations).	33kV * 17 = 561kW.
Each rail car power consumption/per day.	270kWh
Operating hours: Morning 5:30AM Till Mid Night 11.30PM.	17 Hours
A power generation capacity of 16kWh per hour is necessary for the station to transmit electricity to each railcar.	
Total power consumption (for 12 cars*). * Total no of cars = 12.	270kWh * 12 = 3240kWh
Each Rail Car required power from station to station is	7.8kw
Puduvai trans depart Every 6 minute	6 minute
Total number of stations	17
Total power consumption each rail car	7.8*17*=132.6kw

Battery charging current & duration	***Charged energy (at battery terminals)***	***Running distance after charging (without air conditioning)***	***Running distance after charging (at the maximum air conditioning load)***
1000A _ 61sec.	35.6MJ	Equivalent to 7.9km	4.0 km or over
500A _ 3min.16sec.	56.9MJ	Equivalent to 12.7km	6.4km or over

Power Supply: Traction Sub Station
Electric Power System

General

The fundamental difference between the dc-powered and ac-powered systems is that, in dc systems, each substation includes transformers and rectifiers which condition the power to relatively low voltage suitable for direct use by the vehicle propulsion equipment. In ac-powered systems the power is supplied by the substations directly, without rectification, at relatively high voltage necessitating further transformation on-board of the rolling stock for the voltage to be suitable for use by the vehicle propulsion equipment.

Each system type, whether dc or ac, is comprised of the following:

- Traction Power Supply System - includes traction power substations located along the route at predetermined locations.
- Traction Power Distribution System - consists of the overhead contact system (OCS) or third rail system. Additionally, switching stations are required for ac direct-fed systems and along track feeder system, autotransformer stations and switching stations are required for autotransformerfed system.
- Traction Power Return System - comprised of the running rails, impedance bonds, and cross-bonds. In addition, ac electrification systems also use the ground (earth) itself as a part of the return system and are also equipped with static wires and grounding connections.

The traction power supply system delivers power to the distribution system. The trains collect their propulsion power from the distribution system by means of pantographs or third rail current collector shoes, and return the power to the substations via their wheels by the traction power return system.

This section lays down the standards for design and performance and general features of the High Voltage (HV) Electric Power System to be designed, constructed, commissioned and operated by the Concessionaire for the SLR System. The Concessionaire shall supply and commission the SCADA System equipment for the control and monitoring of each high voltage electrical power supply system switching and protection equipment.

A power supply network exclusively for the day-to-day operations (except for the Rail system which shall run solar power) or during any an emergency situation which requires Electricity supply for running of the Rails, to which no other consumer connection is given, shall be applied for and procured from the Puducherry Electricity Department. The traction supply system shall use components and designs proven to be reliable in other similar Suspended Monorail systems. Uninterrupted Power Supply (UPS) shall be provided as per requirements.

The system shall be so designed as to provide sufficient reserve whereby failure of any one electrical equipment does not lead to dislocation of supply warranting intervention. The traction system should be sufficient to operate the Trains at designed speeds over the operating routes, negotiating all gradients and curves. This should include starting from stand still on the steepest grade under crush load of 8 persons per sq m of standing space with all seats occupied.
The capacities, ratings and number of equipment proposed to be connected as determined by the Concessionaire through the engineering development, shall be demonstrated to the IE by simulation study and proper engineering for the services envisaged considering the possibility of equipment failures /small functioning. The short circuit levels and load flow studies on the system during normal and abnormal working and failure conditions shall be determined and coordinated for his design of the Traction Sub-station equipment/Power distribution and RSS arrangements. The traction system should not generate, or risk dangerous interactions with any other system.

Facilities/controls should be provided to manage and control safely the electric traction system in all foreseeable conditions. Egress/fire evacuation measures shall be as per NFPA-130 edition, and fire detection and suppression shall be generally as per NBC-2005. The Concessionaire shall develop the system with the approval of the local fire safety organization. Transformers in receiving sub-station shall be provided with on load tap changer. Concessionaire may use transformers in ASS and TSS with off load tap changers. All 33 kV cables shall have FRLS outer sheath.

System Overview

The Concessionaire shall provide a SCADA System for the management of HV (High Voltage) net works and BMS or BAS (Building Automation System) for LV (Low Voltage) networks. The SCADA shall control and monitor receiving traction and auxiliary power sub-station, associated 33kV distribution cable network and DC traction section feeders via track cabins and disconnection switches. The level of automatic reconfiguration will be as required considering the importance of power supply net work.

Design Considerations

Distribution equipment utilized within the temporary electrical distribution system shall incorporate the following features:

- Flexibility in application for repeated use,
- suitability for transport and storage, and
- robust construction to resist moisture and damage; and safety in use.
- All cabling shall be run at high level whenever possible and firmly secured to ensure that they do not present a hazard or obstruction to people and equipment.
- The installation on Site shall allow convenient access to authorized and competent operators to work on the apparatus contained within.

Mains Voltage

- The Site mains voltage shall be as per the Electricity Authority, 415V/ 3-phase 4 – wire system:
- Single phase voltage shall be as per the Electricity Authority, 230V supply and reduced voltages shall conform to BS 7375.

Power Supply arrangements

The DC electric power supply is required by Maglev Monorail system for the following purposes:

- For running trains:-

The AC electric power supply is required by Maglev Monorail system for the following purposes:

- For station services e.g. lighting, elevators, escalators, signaling & telecom, fire fighting and pumping etc.
- For depots and other maintenance infrastructure within premises of Suspended Monorail system.

The major component of power supply is traction and auxiliary requirements for elevated section.

Types of Distribution Supply

The following voltages shall be adhered to for typical applications throughout the distribution systems:

- fixed plant – 415V/3-phase AC (Auxillary power station), 2MW DC (In main power station),
- movable plant fed by trailing cable – 415V/3-phase,
- installations in Site buildings – 230V/1-phase,
- fixed flood lighting – 230V/1-phase,
- portable and hand held tools – 115V/1-phase, and
- portable hand-lamps (general use) – 115V/1-phase.
- The Concessionaire shall carry out any conversion that may be necessary to enable him to use power from his source of supply.

Estimation of Power

The power requirement of a ***Puduvai Trans*** Maglev Magnetic Monorail system is determined by peak-hour demands of power for traction and auxiliary applications. The power system has been planned for the ultimate single coach train operation at the headway of 6 minute corresponding to 12 trains per hour. Broad estimation of auxiliary and traction power demand is made based on the following requirements:-

Need for High Reliability of Power Supply

The proposed Monorail system is being designed to handle up to 8500 passengers per direction during peak hours when trains are expected to run at about 6 minute's intervals.

The tolerance level of any power interruption during this period is extremely low, as such incidences, apart from affecting train running, will cause congestion at stations. Lack of illumination at stations, non-visibility of appropriate signage, disruption of operation of lifts and escalators is likely to cause confusion, anxiety and ire in commuters, Effect on signaling and communication may affect train operation and passenger safety as well. Accordingly, Monorail system requires a high level of reliable and quality of power supply.

Cables

Cables shall be selected after full consideration of the conditions to which they will be exposed and the duties for which they are required. Supply cables up to 33kV shall be in accordance with BS 6346.251. For supplies to mobile or transportable equipment where operation of the

equipment subjects the cable to flexing, the cable shall conform to one of the following specifications appropriate to the duties imposed on it.

All cables which have a voltage to earth exceeding 65 V (except for supplies from welding transformers to welding electrodes) shall be of a type having a metal sheath and/or armour which shall be continuous and effectively earthed. In the case of flexible or trailing cables, such earthed metal sheath and/or armour shall be in addition to the earth core in the cable and shall not be used as the sole earth conductor.

Armoured cables having an over sheath of polyvinyl chloride (PVC) or an oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring.
For resistance to the effects of sunlight, overall non-metallic covering of cables shall be black in color.

Cables which have applied to them a voltage to earth exceeding 12V but not normally exceeding 65V shall be of a type insulated and sheathed with a general purpose or heat resisting elastomeric.

All cables which are likely to be frequently moved in normal use shall be flexible cables. Flexible cables shall be in accordance with BS 6500 and BS 7375.

All HV power cables shall be XLPE insulated or equivalent, in accordance with IEC 60332 – Part 3 and NFPA 130. Where protection is required suitable ductwork shall be provided. In constrained areas FRLSOH cables shall be provided. Control and Power cables shall be separated throughout the route. All critical, duplicate and/or ring main cables shall be routed separately so that damage to one cable/route will not compromise performance and safety. All cabling and protection equipment shall also comply with the IEC/EN standards as a minimum requirement.

All HV power cables shall be XLPE insulated or equivalent, in accordance with IEC 60332 – Part 3 and NFPA 130. Where protection is required suitable ductwork shall be provided. In constrained areas FRLSOH cables shall be provided. All critical, duplicate and/or ring main cables shall be routed separately so that damage to one cable/route will not compromise performance and safety. All cabling and protection equipment shall also comply with the IEC/EN standards as a minimum requirement.

HV Power Supplies

- The Electric Power supplied by and PUDUCHERRY ELECTRICTY DEPARTMENT shall generally be, as follows:
- Voltage: Uc +10% /-12.5%, where Uc is the nominal voltage; and frequency; 50 +/- 3% Hertz.
- HV Auxiliary Power Supply Systems shall be suitably transformed at each station, to the required voltage.
- Earthing and bonding shall be provided for the electric power system.

- High Voltage supply and Traction Sub Station power supply arrangements shall be finalized by the Concessionaire.
- Normal Train service operation. Manual supervision of the HV network shall be by the Engineering Controller located at the OCC.
- HV Auxiliary Power Supply Systems shall be suitably transformed at each station, to the required voltage.
  Earthing and bonding shall be provided for the electric power system

Power Supply System

Both the sources of supply and transmission and distribution networks shall be reliable, with adequate redundancies built in. It is necessary to obtain power, at least one supply at high grid voltage of 220 or 132 or 66 kV from grid sub-stations. To support the system operations as per the operating plan. The design shall be based on the performance requirements and actual capabilities of the equipment to be supplied.
The system shall provide for:

- Integrity of traction and auxiliary power supplies, and the ability to restore supplies rapidly.
- Ability to re-start services as rapidly as possible after a total failure of traction current supply, particularly to absorb a short-term overload caused by a large share of the Rolling Stock starting within a short period of time.
- Economy in traction energy consumption by regenerative braking.
- Optimum number, capacity and location of sub stations with minimum occupation of space at grade.
- Well designed sub-station buildings.
- Capacity for future system extension without extensive alteration to the existing power supply systems and service interruption on the existing part of the Rail system.
- Switchgear and circuit breakers shall be able to operate on three levels: remote control from OCC, local operation from the substations and manual operation directly on the component.

The power supply system shall be designed for normal operations and contingency operations. The following non-coincidental contingencies shall be assumed:

- Worst case Train delays and Train bunching.
- Failure of one traction sub-station.
- Power feedback from regenerative braking.
- Failure of one utility supply point/interface.
- Abnormal power supply system configuration caused by out-right failures of equipment including feeders, circuit failures and failures of transformers and rectifiers.

UPS system shall be installed to support power supply loads for Depots, essential Station facilities as well as for supporting essential loads of all E&M equipment. The UPS system shall provide high quality AC power to very essential loads under normal and abnormal utility voltage conditions, including power failure. Standby Diesel Generator (DG) Sets Standby DG sets shall be provided at the Stations. They shall cater to the following:

- Essential lighting;
- signaling & telecommunications;
- fire fighting system;
- lift and escalator operations;
- fare collection system;
- security system; and
- UPS loads.

Augmentation

The system design shall permit augmentation by way of adding main power transformers and traction transformer rectifier sets.

Power supply for - Puducherry University station

The power Station is available at 110 kV from 220/110 kV grid sub-station. The place of the substation will be finalized after the kick start of the project. . This Grid sub-station is about 2 km from the Puducherry University station. Although total requirement of power as per estimate is about 13 MVA, it is proposed to plan substation with 15 MVA. This will be reviewed during detailed design stage when rolling stock paramount of energy requirement are firmed up.

Current Carrying Equipment

Power Rails

Current carrying rail of suitable cross section shall be provided on the both sides of the elevated beam of Monorail even of 750 V dc some manufacturers follow +375 V while other follow 750 V dc and above.

Amount of required electric power per rail car

If a railcar arrives and departs every 6 minutes, a power generation capacity of 9.6kWh per hour is necessary for the station to transmit electricity to each railcar. When we assume that the first train of the day is 5:30 a.m. and the last train is 11:30 p.m., the electric power necessary for a day is 270kWh.

Rating of Power Supply Cables, Feeders and other details

- For the estimated load 15 MVA appxo, two 3-phase circuits of 66 kV, XLPE insulated 630-mm2 Aluminium (single core) shall be drawn and laid through public pathways by the ***Puduvai Trans*** Monorail Authority's 110 kV /33 KV/66 kV Grid Sub Station from Puduvai to Karanthai
- Two 3-phase circuits of 110 kV, XLPE insulated 630-mm2 Aluminium (single core) shall be drawn and laid through public pathways by the Monorail Authority's 110 kV Grid Sub Station at Alli to Mullai station
- Two 3-phase circuits of 110 kV, XLPE insulated 630-mm2 Aluminium (single core) shall be drawn and laid through public pathways by the Monorail Authority's 110 kV Grid Sub station at Venkai to Vaagai.

- Two 3-phase circuits of 110 kV, XLPE insulated 630-mm2 Aluminium (single core) shall be drawn and laid through public pathways by the Monorail Authority's 110 kV Grid Sub station at Culli to Kurinji.

However, the final cable ratings and type will once again be finalized during the kick off period of the project by the project team.

Traction Power Supply System

On elevated Beam, Current carrying Power Rails are to be provided on both sides of the beam (i.e. +ve as well as –ve return rails). The Power rails are insulated from the track beam. Since the path of the Suspended Monorail- everywhere on elevated track beams is completely isolated, free of public and not accessible even to staff other than highly skilled staff with proper permits to work, hence the system is safe.

In the 750V DC or 415V DC Traction Suspended Monorail System due to higher specific energy consumption and lower voltage the traction currents are high. Moreover, number of parallel circuits/ conductors cannot be increased, as there is constraint of running the cables on the viaduct/elevated beam, therefore, the 33KV/66KV distribution network for the Metro Traction system is a proven and time tested technology and have become a norm and ring main systems for both Traction Sub Station feeders and Auxiliary Substation feeders is recommended.

Earthing and Bonding

Since this is four rail system completely separated from the running beam track the adverse effect of corrosion shall not be predominant. Therefore, limited measures shall be required for earthing and bonding.

- The earth leakage and frame leakage relays shall be provided for substation equipment. If the fault current levels are of the order of load currents carrier protection/ pilot wire protection may be required, which may necessitate 4 or 6 pair twisted core shielded cable in addition to the power cables. Pilot wire protection shall also be required for Inter tripping of adjacent HSCBs in case of line faults.
- Floating system has been used by Monorail. Thus reduces the dc stray current to considerable level. The arrangement shall comply with following latest CENELEC standards:-
- EN 50122-1:- Railway Applications (fixed installations) protective
- Provisions relating to electrical safety & earthing.
- EN 50122-2:- Railway Applications (fixed installations) protective
- Provisions against the effects of stray currents caused by dc traction system.

Basis for Planning Traction Substations

The traction substations (TSS) have been planned to keep the voltage drop within permissible limits. The design and capacity of RSS and TSS has been selected to cater for the eventualities of total failure of one Source/feeder, RSS, TSS or a subsystem. The distance between two TSS's is estimated about 3 to 4 km (depending up on voltage drop). Thus, the gap between any two substations will not be more than four-five stations to limit the number of simultaneous starting

trains on each TSS. In case of failure of any TSS the feed of the next Traction substation will be extended may require controlling of the trains.

Location of Traction Substations

All the stations will have sub-power stations. These sub-stations will have all the necessary components for battery backup storage, and the initial thrust circuits for making the vehicle to start from dead stop.

Traction Power In MVA For The Corridor Is 5.5.
The traction power requirements estimated above discounted power/regenerated during braking @ 20%.

Selection of Traction Voltage

The traffic requirements of the ***Puduvai Trans*** Maglev Monorail have been projected to be about 4800 and 5000 PHPDT. The corridors will be elevated. For this level of PHPDT technically traction voltage at 750 V dc will suffice. Maglev Magnetic Monorails are worldwide available with 750V DC systems. The Monorail in Mumbai is using 750V DC. Keeping in view of traffic requirements, aesthetics and other techno-economic considerations, 750V dc type traction systems is considered suitable.

Traction Power System

Traction current shall be supplied to lines in sections, separated by gaps in conductor rails. Sections should be double end fed from Traction sub stations (TSS) except the sections towards a depot which is single end fed.

TSSs shall be sized to accept suitable power over load (minimum 50%) for duration of 2 hours. Traction sub stations along with Auxiliary Sub-Stations (ASS) shall be located in the close vicinities or in the station building inside a room. Additional ASS shall be located at each maintenance Depot. When located outside, it can be underground with safety features as per rules/regulations in force.

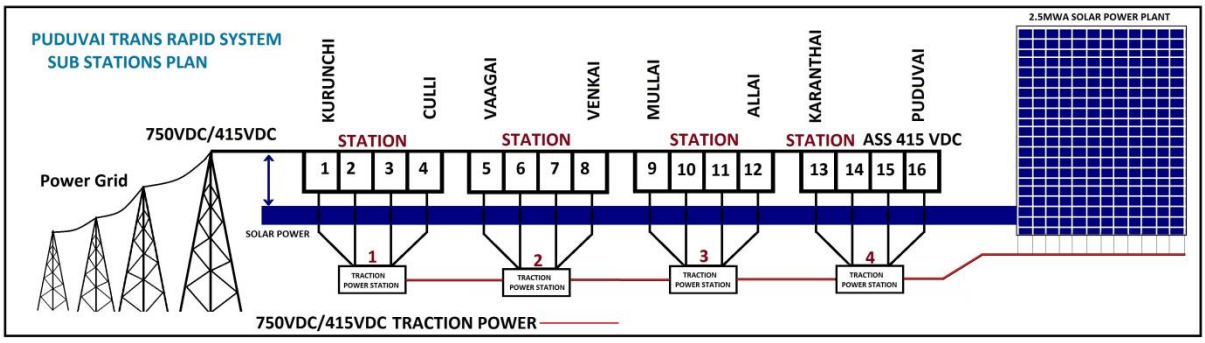
Each TSS shall have transformer-rectifier sets of suitable capacity with provision for an additional set to be installed at a future date, in order to supply DC voltage as per design to the third rail. From the TSS, DC cables of required voltage capacity shall be laid up to third rail and return current cables shall be connected to running rails. Self-cooled, cast resin dry type transformer-rectifier shall be provided for indoor application. Transformer and rectifier shall conform to IEC 61000, IEC 60146, EN 50327, EN 50328 and EN 50329. Single phase XLPE insulated cables with minimum 400 mm sq. copper conductor or equivalent or more as per design requirement shall be provided for transfer of power from TSS to third rail. Number of cables required depends on power requirement.

Traction supplies shall be distributed at 750V DC or as per design voltage in accordance with IEC 60850, Railway Applications – Supply Voltages of Traction Systems. 750V DC Stringer type of current collection systems shall be provided in Depot.

Traction sub-stations (TSS) shall be set up for feeding DC power supply as per design to the third rail. They shall be distributed all along the line so as to be evenly loaded so that the line will not be subjected to voltage levels unacceptable to the Rolling Stock in the event of shut down of a TSS. TSS may be installed for stations and one for the Depot. The number, capacity and configuration of the traction sub stations shall be decided by the Concessionaire in consultation with the IE to meet the overall reliability, availability and technical requirements.

- The third rail design shall be in accordance with BS 7865, EN 50122-1 and EN 50122-2.
- The third Rail and interface equipment shall be protected from switching surges and lightning strikes.
- The third rail is designed so that in the event of a single failure of a mechanical element the system shall not cause a hazard and wherever practicable allow continued operation of the Rail System.
- Third Rail system and equipment with a proven history of service on similar Rail Systems shall be employed.
- The Third rail conductor shall comply with international standards and shall have a continuous rating commensurate with power supply rating in still air at the highest maximum ambient temperature and solar radiation levels to be expected on the Rail System. This rating shall be achieved without exceeding the Third Rail conductor maximum temperature.

Control and monitoring of track circuit breakers provided for energizing the third rail shall be carried out from the ATS part of the OCC. Additionally, OCC shall have the control to trigger an Emergency de-energizing of the entire line or a section there of.



9.14- Auxiliary Power Supply System

The ASS's is provided in all the station premises and power to the auxillary substations are received from the main sub-stations. All the stations are connected through cabling from the ASS.

The auxiliary power will be required for:

- Stabling sidings.
- Platforms.
- Service buildings.

- Stairs/Concourse.
- Maintenance depots.
- Traction substation buildings.
- Ventilation & Air-conditioning.
- Elevators – Machine Room less Elevators, for 8/13 Passengers 1 m/sec speed.
- Escalators, Elevator & Escalator provision is kept for future at all the stations.

Basis of Planning Auxiliary Sub Stations (ASS)

Station load

2x350KVA ASS of 33KV/66KV/110KV/750 V DC or 33KV/66KV/110KV/415 V DC with DG sets and UPS have been planned for station loads except at some stations where commercial development may derive power of 500 KVA. Each Station shall be provided with an independent ASS. The demand of power at each elevated station is expected to be about 300 KW.

Auxiliary Supply Substations (ASS – For station electrical utilities purpose only)

Power Transformers

Power Transformers shall be in accordance with EN 60076. Two transformers shall be provided in each ASS, configured for redundant operation.

(i) Elevated/at –grade station load –300KW (to serve future provision of Elevators and Escalators at each station) and for stations with commercial development, it will be 350 KW.
(ii) Final Depot auxiliary load - 1050 KW.

Electricity board practices and Limitations for ASS

This project aims in providing ASS's near the main sub-station. All the stations are connected through cabling from the ASS.
If there is going to be some limitations and practical scenerios where the ASS should be kept in all station premises only, then each station shall be provided with an ASS with two indoor type 33kV/750V, 3- phase, 350 kVA transformers and the associated HT & LT switchgear and for commercial development stations 500kVA transformers shall be provided. The demand is based on level of services required at the stations given in the following section. The ASS will be located at mezzanine or at station platform level inside a room.

Performance Specification for ASS

Auxiliary Power Supply System
The Concessionaire shall provide a 33kV 3-Phase ring-main circuit within the Rail system infrastructure, providing redundant connections to Auxiliary Sub-station (ASS) at each station, Depot a Two ASS transformers shall step down the 33kV 3-phase to 415V 3-phase and 240V 1-phase supplies. Each transformer and associated switchgear shall normally supply part of the ASS load and in the event of a failure or maintenance activities, one transformer shall automatically assume the full load of the ASS.

The ASS control panel fast acting protection equipment shall monitor the transformers and switchgear performance and immediately enable the isolation of defective equipment. Each ASS shall be supervised by the Engineering Controller at the OCC, via the SCADA System. The SCADA System shall automatically re-configure the Auxiliary Power System during failure and maintenance activities alarm the Engineering Controller, record power consumption and maintain a log of events.

Selection of Supply Voltage for Receiving (Main) Sub-Station

To ensure reliability of power supply, it is essential that supply is taken at least from two sources and the connected transmission networks are reliable and have adequate redundancies built in. Grid substation voltage available in Puducherry is at 110 KV and 66 KV. Therefore, it is proposed to obtain power supply at grid voltage of 110kV or 66kV from stable grid sub-stations and further transmission & distribution to the stations along the corridor will be by the ***Puduvai Trans*** Maglev Magnetic Monorail Authority itself. Whether reliable 33 KV ring is available in the city is not known. It will be ascertained when the project kicks off.

Location of Receiving (Main) Substation

The city has 220kV- 230kV grid supply at periphery of the city at Grid substation, where it is stepped down to 110kV. The power supply to this Grid sub-station is from Area code Generating station.

The 110kV supply is stepped down at Puducherry University station Grid sub -station to 33/66kV level. The power supply to this grid substation is reliable as it is connected to:

- Grid.
- Generating station.

Sub-station Equipment

- An RTU shall be provided at each RSS and ASS sub-station to communicate with the central SCADA servers. The RTU shall interface with the Remote Input/Output (RI/O) units of which the field equipment to be monitored or controlled are connected.
- A Local Control Panel shall be provided in each sub-station for the monitoring and control of all the equipment associated with a particular RTU. For the event of loss of the OCC, a fall-back arrangement shall be provided to enable the supervision of the entire Electric Power System.

Energy Saving Measures

Energy charges of any Monorail system constitute a substantial portion of its operation & maintenance (O & M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The auxiliary power consumption of metros is generally more than the traction energy consumed by train movement during initial years of operation. Subsequently, traction power consumption increases with increase in train frequency/composition in order to cater more traffic.

Monorail includes the following energy saving features:

- Modern Monorail rolling stock with 3-phase VVVF drive and lightweight coaches has been proposed, which has the benefits of low specific energy consumption and almost unity power factor.
- Rolling stock has regeneration features and it is expected that 20% of total traction energy will be regenerated and fed back to 750 V dc third rail to be consumed by nearby trains.
- Effective utilization of natural light is proposed. In addition, the lighting system of
- the stations will be provided with different circuits (33%, 66% & 100%) and the relevant circuits can be switched on based on the requirements (day or night, operation or maintenance hours etc).
- Machine-room less type lifts with gearless drive have been proposed with 3- phase VVVF drive. These lifts are highly energy efficient.
- The proposed public services escalators will be provided with 3-phase VVVF drive, which is energy efficient & improves the power factor. Further, the escalators will be provided with infrared sensors to automatically reduce the speed (to idling speed) when not being used by passengers.
- The latest state of art and energy efficient electrical equipment (e.g. transformers, motors, light fittings etc) have been incorporated in the system design.
- LED lighting is proposed in certain areas. Efficient energy management is possible with proposed modern SCADA system by way of maximum demand (MD) and power factor control.

Electric Power Tariff

The cost of electricity is a significant part of operation & maintenance (O&M) charges of the ***Puduvai Trans*** system, which constitutes about 30-35% of total annual working cost. Therefore, it is the key element for the financial viability of the project. The annual energy consumption is assessed to be about 32 million units in the horizon year (2041). It is proposed that takes necessary steps to treat Kerala Suspended Monorail project as a special category of consumers whose tariff should be based upon the actual cost of supply, excluding both the subsidy and cross-subsidy elements i.e. at 'No Profit No Loss' basis. This is expected to be in the range of Rs. 3.50 – 4.00 per unit, so that the annual energy bill can be substantially reduced. ***Puduvai Trans*** services deserve this on the considerations given below:-

Puduvai Trans is to be executed as a public utility and a social sector green field project with a view to improve mobility of commuters and reduce congestion and pollution on roads and faster travel at affordable rates for which electricity is the only source of energy for operation and Suspended Monorail system and if constitutes about 1/3rd of cost of operation & maintenance.

• For this power supply will be taken at 110kV or 66kV grid points of PEB.

• Further transmission and distribution for Suspended Monorail operation at 750 V DC / 415 V DC and other passenger services is through 33kV network of Maglev Magnetic Two-tier Monorail with built in redundancies to ensure reliable supply for the system.

• For ***Puduvai Trans*** Maglev Magnetic two-tier Monorail will be setting up 2 Receiving Sub-stations at 110kV and 66kV and 33kV sub-station and cabling at their cost.

• It will not utilize local authorities' distribution network.
• It will not attribute any losses below 66kV. It will only contribute in redundancy losses of distribution system of local authorities.
• During peak hours, there will be 8,000 to 10,000 passengers and any disruption of supply will inconvenience passengers. For this Maglev Magnetic Two-tier Monorail will provide built redundancies at their cost. Similar approach has been adopted in Delhi and Bangalore where MRTS is working.

Metering

The OCC equipment shall comprise the Engineering Controller workstation, mimic panels Digital Light Processing (DLP) unit or other systems, conforming to the Specifications set out in this Manual, displaying the entire Traction Power System and Auxiliary Power System. Two hot-standby redundant servers shall acquire real time equipment status from the Remote Terminal Unit's (RTU), process operator commands and perform the core SCADA functions.
Any change of state of an input shall be reported at the OCC within 4 seconds of the occurrence.
Any System reconfiguration time shall not exceed 10 seconds.

Protection for Safety against electrical shocks

- Protection facilities with fast discrimination and reliable operation, based on micro-processor technology, shall provide the protection scheme logic. The zones of protection shall overlap providing back-up protections. The scheme for protection shall be fully coordinated.
- The Concessionaire shall ensure that discrimination between all forms of Station substation protection is such that equipment failures cause minimum disruption to the Rail System operation.
- An interlocking and protection scheme that prevents inadvertent or spurious re-energisation of the supply shall be ensured.
- The Earthing system shall conform to EN 50122-1Railway Applications-Fixed Installations. Protective Provisions Relating to Electrical Safety and Earthing and EN 50122-2.Railway Applications-Fixed Installations.
- Protective Provisions against the effects of stray currents caused by DC traction systems.
- The Earthing System for Stations, Depot and Line-side structures shall comply with the BS 7430 Code of Practice for Earthing.
- At Stations and line-side structures, copper earth mats and connecting conductors shall be used. Down conductors fixed to viaduct columns, connecting the Structure Earth mat/spike to the viaduct bus bar may be provided as Aluminium.

System Earthing

Earthing and bonding equipment shall be embedded in the civil structures. System protective earthing for providing electrical safety at Stations, substations, line-side buildings shall be

provided. The Concessionaire shall engineer the earthing system on the basis of safety for people against hazardous touch and step potential and fire hazards and in accordance with provisions of IEC-61936.1. Power Installations exceeding 1kV AC, IEC 60364-4-41: Low voltage Electrical Installations. Part 4-4 Protection for Safety against electrical shocks, and NFPA 130.

The Earthing system shall conform to EN 50122-1Railway Applications-Fixed Installations. Protective Provisions Relating to Electrical Safety and Earthing and EN 50122-2.Railway Applications-Fixed Installations. Protective Provisions against the effects of stray currents caused by DC traction systems. The Earthing System for Stations, Depot and Line-side structures shall comply with the BS 7430 Code of Practice for Earthing. At Stations and line-side structures, copper earth mats and connecting conductors shall be used. Down conductors fixed to viaduct columns, connecting the Structure Earth mat/spike to the viaduct bus bar may be provided as aluminium.

Earthing and bonding shall be provided for all electrical installations and equipment to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by installed circuit protection.

- Earthing systems shall conform to the following standards: IEE Wiring Regulations (16th Edition).
- BS 7430.
- BS 7375 and

IEEE Standard 80 Guide for Safety in AC Substation Grounding.

Earth System conductance

Structure Earthing System for viaduct sections of the track the equi-potential bonding of the metallic re-inforcing in stations and line-side buildings shall be connected to the associated Building Earth System specified in Chapter 11. Viaducts shall be sectionalized at, approximately two beam lengths, and the Bonding of metallic re-inforcing in viaduct structures, slab-track bed; handrails, and the like, shall be connected to a common Structure Earth.

Electrical Protection Systems

Protection facilities with fast discrimination and reliable operation, based on micro-processor technology, shall provide the protection scheme logic. The zones of protection shall overlap providing back-up protections. The scheme for protection shall be fully coordinated.
The Concessionaire shall ensure that discrimination between all forms of Station substation protection is such that equipment failures cause minimum disruption to the Rail System operation.

An interlocking and protection scheme that prevents inadvertent or spurious re-energisation of the supply shall be ensured.

Protection of Circuits

Protection shall be provided for all main and sub-circuits against excess current, under and over voltage, residual current and earth faults. The protective devices shall be capable of interrupting

(without damage to any equipment or the mains or sub-circuits) any short circuit current that may occur.

- Discrimination between circuit breakers and fuses shall be in accordance with:
- BS 88.
- BS EN 60898.
- BS 7375 and

Any other appropriate Indian Standards.

Insulation Coordination

Equipment shall have insulation levels according to EN 50124, Railway Applications – Insulation co-ordination.

Operational energy

Strategies for minimizing energy use and maximize energy efficiency include:

Puduvai Trans

- Reduced aerodynamic resistance.
- Regenerative braking.
- Reduced weight of trains (aluminium car bodies and lighter propulsion equipment reduces weight).
- Humped tracks (to assist braking and acceleration at stations).
- Optimize track alignment and grading.
- Demand ventilation control – target temperature modified to improve energy efficiency and maintain comfort conditions.
- Energy efficient lighting.

Stations

- Passive environmental control system (natural ventilation and day lighting).
- Energy efficient environmental control system (demand operated ventilation and alternatives to air conditioning).
- Maximum use of stairs rather than escalators (dependent on station depth).
- Energy efficient lifts and escalators.
- Sensor operated escalators.
- Energy efficient lighting.
- Integrate solar photovoltaic cells/thermal within building structures.
- Building orientation.
- Improved building fabric energy efficiency and review building specifications,
- Developments related to stations to ensure that new buildings reduce overall energy demand, including ancillary facilities, retail areas and operation/maintenance areas.

Stabling yards and depot

- Passive natural ventilation system.
- Day lighting.
- Energy efficient lighting.
- Energy efficient plant.
- Hybrid/fuel cell maintenance vehicles/plant.
- Integrate solar photovoltaic cells/solar thermal within building structures.
- Energy efficient lighting.

Thermal and ventilation modeling

Thermal and ventilation modeling should be conducted to understand the likely performance of the stations, depot and trains and thereby to determine requirements for climate control systems. Climate control performance standards should then be set and the options for meeting these standards assessed, taking into account the energy efficiency of the various options available.

Energy modeling

Energy modeling should be undertaken to calculate and anticipate energy consumption based on the findings of this feasibility study. This will provide a baseline from which to measure energy consumption throughout the life of the project. As the design is refined, this baseline can be updated to document the energy savings which can be delivered through energy minimization and efficiency strategies as well as opportunities for generating energy from renewable and low carbon sources.

Materials minimization and resource recovery

Materials minimization and resource recovery strategies

- The ***Puduvai Trans*** aims to conserve materials (by minimizing resource use and maximizing resource recovery) and minimize the environmental impact associated with the resources consumed where possible through implementation of the following strategies.
- Developing and implementing sustainable procurement policies with the construction working group and contract administrators.
- Providing reuse and recycling training and facilities in stations, depot and offices for use by staff.
- Providing reuse and recycling training and infrastructure at construction sites.
- Setting construction reuse and recycling targets and monitoring waste generated to determine where improvements can be made.
- Beneficially reusing 100% of useable spoil.
- Promoting the use of design for flexibility and deconstruction principles.
- Promoting minimal resource use as a design target.

General

Investigate use of alternative energy sources and the use of renewable energy during operation of the ***Puduvai Trans***. Commit to purchasing a set percentage of energy from a renewable source during operation.

Life Cycle Analysis

Life cycle analysis could be undertaken to calculate the embodied materials, energy, waste and emissions from materials consumed in construction of the ***Puduvai Trans*** . This will assist in materials selection and provide a baseline from which to measure the project's performance in terms of materials over its full life cycle, including requirements for refurbishment and ultimately disassembly and reuse/recycling of project components. Life cycle analysis should include analysis of use of recycled materials in construction and opportunities for reducing embodied energy and waste and also creating markets for recycled materials. Whole of life cost would form an element of this life cycle analysis.

Biodiversity

Enhancing biodiversity as part of the ***Puduvai Trans*** will be a challenge given the highly urbanized nature of the areas affected. However there are opportunities for biodiversity improvements through increasing vegetation during and after construction to provide shade, improve micro-climate and air quality and enhance the overall urban aesthetic (e.g. landscaping, vertical gardens/green walls/bio walls).

Community and Stakeholder Engagement

Actively engaging the community and stakeholders should promote public support for the project and maximize patronage. To achieve these objectives, the following strategies should be implemented:

Develop a strategy to actively engage the community in design of the stations and station precincts and the public realm to optimize way-finding, access, facilities and the quality of customer experience

Investigate opportunities for obtaining funding for sustainability initiatives from other sources, including government grants programs and funds (e.g. Green Precincts Fund).

Sustainability Management System

A system of sustainability governance will need to be established at the outset of the next project stages to set the direction and guide the process of integrating sustainability considerations into the design, construction and operation of the ***Puduvai Trans***. Implementation of a sustainability management system would provide clear definition of sustainability objectives and targets and enable processes and project team responsibilities to be defined along with systems of monitoring and performance reporting.

Fire Protection requirements

All requirements in respect of fire protection shall be as in Part IV, Fire Protection in National Building Code of India, 1983 and amendment No.3 under Fire Protection Annexure II. Therefore, the provision of NBC will prevail for Suspended Monorail at Puducherry.

In view of above, the pump/hydrant, hose reel, and fire fighting systems have been reviewed. The details have been covered in the relevant chapter in DPR. The fire fighting system envisaged at ***Puduvai trans*** elevated station contains:-

- Internal hydrant.
- Sprinklers.
- Detectors.
- Manual call box.
- Manual panel gas flooding.

9.15-Signaling and Train Control

Introduction

The Signaling System for Puducherry mono rail system will provide the means for an efficient train control, ensuring safety in train movements. It enables optimization of infrastructure investment and running efficient train services with scalable headway on the network.

Overview

The ***Puduvai Trans System*** carries large number of passengers at close headway requiring a very high level of safety enforcement and reliability. At the same time heavy investment in infrastructure and rolling stock necessitates optimization of its capacity to provide the best services to the public. These requirements of the Mono Rail are planned to be achieved by adopting Communication based Train Control (CBTC) generally conforming to IEEE 1474 and ATS (Automatic Train Supervision) Sub-systems. Signaling and Train Control System will be capable of running trains at operational headway up to 120 seconds (the design headway of 100 sec). This will:

- Provide high level of safety with trains running at close headway ensuring continuous safe train separation.
- Eliminate incidences of Signal passing at Danger by continuous speed monitoring and automatic application of brake in case of violation of MSS, disregard of signal aspect / MSS by the Train Operator.
- Enforces speed limit on section having permanent and temporary speed restrictions.Improve capacity with safer and smoother operations. Driver will have continuous display of Target Speed in his cab enabling him to optimize the speed potential of the track section. It provides signal / speed status in the cab even in poor visibility conditions.
- Increased utilization of rolling stock by increasing line capacity, train speeds and headway. Hence more trips will be possible with the same number of rolling stock and civil infrastructure.
- Improve maintenance of Signaling and telecommunication equipments by monitoring system status of trackside and train borne equipments and enabling preventive maintenance. Signaling & Train Control system on the line shall be designed to meet the required headway during peak hours.
-

System Description and Specifications

The Signaling and Train Control system shall be as below. Sub-system/ components will conform to international standards like CENELEC, IEC, IEEE, IS, ITU-T etc:

Continuous Automatic Train Control

Continuous Automatic Train Control will consist of - ATP (Automatic Train Protection), ATO (Automatic Train Operation) and ATS (Automatic Train Supervision) sub-systems:

Automatic Train Protection (ATP)

Automatic Train Protection is the primary function of the train control systems. This subsystem will be inherently capable of achieving the following objectives in a fail-safe manner. Line side signals will be provided, which shall serve as back-up signaling in case of failure of ATP system. In such cases, train speed will be automatically restricted to 25 kmph.

- Cab Signaling.
- Track Related Speed Profile generation based on line data and train data continuously along the track.
- Continuous monitoring of braking curve with respect to a defined target point…
- Monitoring of maximum permitted speed on the line and speed restrictions in force
- Detection of over-speed with audio-visual warning and application of brakes, if necessary.
- Maintaining safety distance between trains Monitoring of stopping point.
- Monitoring of Direction of Travel and Rollback.
- Support De-graded mode of operations for particular train/Area of Control.
- The cab borne equipment will be of modular sub-assemblies for each function for easy maintenance and replacement. The ATP assemblies will be fitted in the vehicle integrated with other equipment of the rolling stock.

Automatic Train Operation (ATO)

This system will operate the trains automatically from station to station while remaining within the safety envelope of ATP & open the train doors. Driver will close the train doors and press a button when ready to depart. In conjunction with ATP and ATS, ATO will control dwell time at stations and train running in accordance with headway/ timetable.

Driverless Train Operation

In a driverless operation system, trains run without a driver on board. Train operation and status is remotely controlled and adjusted from the OCC based on the two-way Radio Frequency-Communication Based Train Control (CBTC). This high-end system can minimize faults and operation delays through securing redundant systems and automatic route change functions. This operation system also ensures safety through minimizing human error, which accounts for the largest portion out of the cause of railway accidents. The term ATO is used to

cover a wide range of levels of automation, from the automation of the basic driving operation alone to the running of trains with no staff member on board. The universally adopted concept for identifying the level of automation is levels of "Grade of Automation" (GOA), with GOA level 1 being ATP only with no ATO.

The Semi-automatic Train Operation (STO) or GOA level 2 refers to ATO which enables trains to run automatically from one station to the next, under the protection of an ATP system and under the supervision of a train driver. With STO, the driver remains in the cab of the train, operates the doors, provides the start signal for the train to leave a station, and monitors the performance of the train and the track ahead.

The next level of automation is referred to as Driverless Train Operation (DTO) or GOA level 3. In DTO, the driver is able to move away from the front of the train, but remains available to provide help to the customers facing difficulties and to drive the train in the event of a failure of the ATO system. In DTO, train doors and train departure from a station platform may be controlled automatically or manually from a location other than a drivers cab at the front of the train.

Driverless ATO without an on-board attendant is referred to as Unattended Train Operation (UTO) or GOA level 4. UTO can range from empty train movements only (to a siding, or in an automated depot for example) to the operation of trains in passenger service with no attendant on board. Driverless operation system is universalized and is operated over 100 transit lines around the world. The automation level in Puducherry Mass Transit System proposed is GOA level 3 (DTO) with availability of trained staff in train.

Benefits of Driverless Train Operation

Train operation is automated by pre-arranged programs, and is committed to providing safe and faster transport service for passengers via OCC equipped with cutting-edge technology through:

- Decrease in safety accidents incurred by human error.
- Increase in efficiency of operating personnel.
- Observation of external view from inside the train.
- Reduction in energy consumption.
- Cost-efficiency and consistent operation.
- Less congestion due to maximum train operation during revenue operation hours.
- Prompt switch-over of a leading cab during train turn-back (Multifunctional personnel reduction cost in the long run).
- Flexible Train operation.

The apprehension associated with driverless train operations are:

- Handling of failures on a driverless train car.
- Anxiety of passengers for a driverless train car.

Handling of failures on a driverless train

The problem of attending a failure on a driverless train is of utmost concern as it poses a serious constraint on the operations. This can be resolved by:
Posting a trained attendant in trains to attend and act as first line maintenance support and by establishment of emergency transportation tools and systems for dispatch to an incident site at designated stations. Besides, mobile maintenance teams can also be deployed at such stations to ensure that the failure situation is promptly attended and the impact is minimized.

Anxiety of passengers for a driverless train

The driverless trains are now well adopted the world over. Still, the idea of a train without a driver is something which the public is not very comfortable with, at least initially. To overcome this anxiety the implementation of driverless train will be done in a phased manner. Initially, the trains will run in ATP mode which is a driver driven mode, then ATO will be implemented which again has a driver. Lastly, in the final phase, the trains will be run driverless, albeit with a trained staff, having a train driver license in order to address possible anxiety of passengers and immediately deal with any train faults. Driverless Train Operations is being adopted the world over. The driverless operation offers advantages of quicker turnaround, better throughput and no dependence on the human factor. Hence it is proposed to adopt driverless operation in

Puduvai Trans
Automatic Train Supervision (ATS)

A train supervision system will be installed to facilitate the monitoring of train operation and also remote control of the station. The train supervision will log each train movement and display it on the work stations with each Traffic Controller at the OCC and on one work station placed in the Station Control room (SCR) (at interlocked stations) with each Station Controller.

The Centralized System will be installed in the Operation Control Centre. The OCC will have a projection display panel showing a panoramic view showing the status of
switches, signals and the vehicles operating in the relevant section/ whole system. ATS will provide following main functionalities:

- Automatic Route setting.
- Automatic Train Regulation.
- Continuous Tracking of train position.
- Display Panel & Workstation interface.
- Adjustment of station dwell time.
- Link to Passenger Information Display System for online information.
- Computation of train schedules & Timetable.

Interlocking System

Computer Based Interlocking (CBI)

Computer Based Interlocking (CBI) will be provided for operation of switches and setting of routes at the Two Terminal Stations (Rajiv Gandhi bus stand to puducherry University via state entrance), New Bus Stand station and Depot.

The setting of the route and clearing of the signals will be done by work station, which can be either locally (at station) operated or operated remotely from the OCC., either manually by the Traffic Controller or automatically by ATS. This sub-system is used for controlling vehicle movements into or out of stations automatically from a work station. All stations having switches will be provided with work stations for local control. Signal status, Switch position, etc. will be clearly indicated on the work station. It will be possible to operate the work station locally, if the central control hands over the operation to the local station. The interlocking system design will be on the basis of fail-safe principle.

The equipment will withstand tough environmental conditions encountered in a Mass Transit System and suitable for weather conditions in Puducherry, Control functions in external circuits will be proved both in the positive and negative wires. Suitable IS, IRS, IEEE, BS Standards or equivalent international standards will be followed in the case of wiring, installation, earthing, cabling, power supply and for material used in relays, switch operation machine interfaces, power supply etc.

Train detection

Radio Communication based Train detection will be used for vehicle detection.

Switch operation and detection interface

Necessary interfaces for operation of switches and their detection by interlocking will be provided. For the proposed signaling plan attached as annexure, the position of switch can be at a distance of 10 m from the edge of the nearest platform. CCTV coverage on all the switches is proposed with two cameras per switch, covering the complete switch. This will help the OCC/SC to ascertain the condition of switches in case of any point failure and will also be helpful in remote monitoring of the switches.

Headway

- The Headway calculations are based on two components namely, the inter-station headway and the turn back headway.
- The inter-station headway is typically the time when the lead train has just cleared the station stopping point, after the dwell time, by sufficient margin, to allow the following train to place its target point at the station stopping point.
- The turn back headway is similar to inter-station headway, but also accounts for the time needed for route initiation, switch operations required for crossing to opposite track, travel time over point zone and any other associated delays.

With smaller train length, straight run, sufficient inter-station run time and multiple trains in section, the inter-station headway is always better than the turn-back headway. Thus the ruling constraint in headway consideration is turn back headway which is calculated on the following assumptions:

Track Data

- The maximum operating speed is assumed to be 80km/h.
- Total switch move time is assumed to be 10 seconds.
- The dwell time is defined as wheel stop to wheel start at all stations.
- Defined as 20seconds for all stations.
- The maximum speed over Crossover Track is assumed to be 30 km/h.

The turnback headway is calculated as:
HW= TEntry+ TDwell +TExit +TSwitch +TSystem
TEntry= Time taken by train to travel from Up line to Dn Line = 30 seconds.
TDwell= Dwell Time on Platform = 20 seconds.
TExit= Time taken by train to travel from Dn Platform to clear the switch zone = 30 seconds.
TSwitch= Switch Movement Time = 10 seconds.
TSystem= System Switchover Time = 10 seconds.
Therefore, **HW= 30+20+30+10+10 = 100 seconds**

Train Depot: Signaling

All Depot lines, except the ones used for shunting in workshop, shall be interlocked. A work station shall be provided in the Depot Control Centre for operation of switches, signals and routes of the depot yard. Train detection will be radio based. Line side signals for diverging routes will be provided.

Standards

The following standards will be adopted with regard to the Signaling system.

Description	*Standards*
Interlocking	Computer based Interlocking adopted for station having switches and crossing. All related equipment as far as possible will be centralised in the equipment room at the station. The depot shall be interlocked except for lines mainly used for shunting
Operation of switches	Through interface from interlocking
Train detection	Communication based
Signals at Stations with switches	Line Side signals to protect the switches. LED type signals for reliability and reduced maintenance cost.

UPS (uninterrupted power at stations as well as for OCC)	For Signaling, Tele-communications and AFC
Train protection system	Automatic Train Protection system (CBTC) with fall back arrangement for Train Control, generally, as per IEEE 1474 or equivalent.
ATO and Driverless operation	Will be introduced in phased manner
Train Describer System	Automatic Train Supervision system. Movement of all trains to be logged on to a central computer and displayed on work stations in the Operational Control Centre and at the SCR of interlocked stations. Remote control of stations from the OCC.
CCTV Coverage of Switches	Switches will be covered using two CCTV cameras on each switch for remote monitoring.

Description	Standards
CCTV coverage in Train Coaches	The train coaches will have CCTV cameras for surveillance, to remotely access the situation and issue instructions to passengers if needed.
Redundancy for TP/ Train Describer.	Redundant Train borne equipment and ATS equipment at OCC.
Cables	Outdoor cables will be steel armoured as far as possible.
Fail Safe Principles	SIL-4 safety levels as per CENELEC standard for
Immunity to External Interface.	All data transmission on telecom cables/OFC/Radio will have suitable means of immunity to external environment. All Signaling and telecom cables will be separated from power cables. CENELEC/IEEE standards to be implemented for EMC/jamming.
Train Working under emergency/degraded mode	Running on site with line side signal with speed automatically restricted at 25 kmph.
Environmental	Air-conditioners for all equipment rooms.

Independent Safety Assessor (ISA)

Independent Safety Assessor would be required to audit the Signaling system and suppliers' processes and approve the same for Safety certification. There are no local ISA's available in India. An ISA will have to be engaged for the Puducherry Mono Rail.

Space Requirement for Signaling Installations

Adequate space for proper installations of all Signaling equipment at each of the stations has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system.

- The areas required at each of the stations for shall be generally :
- For Signaling equipment room at interlocked station with switches - 50 sq.m for UPS Room (common for signaling and telecom) - 50 sq.m

The OCC will be located in the Depot. The ground floor will accommodate S&T Equipment and UPS. First floor will be used for OCC Theatre. At the OCC, the areas required shall be:

- For OCC theatre- 250 sq. m.
- Signal and Telecom equipment room at OCC: 250 sq. m.
- Central computer and NMS for AFC system: 100 sq. m.
- Communication System supervisor - 36 sq. m.
- UPS room at OCC: 50 sq. m.
- Space for S&T spares storage in depot: 100 sq. m.
- The Depot control centre (DCC) equipment will be co-located with S&T equipment at OCC. DCC will be accommodated in the OCC theatre.All the rooms will be air-conditioned. The OCC theatre will also accommodate CCTV monitoring by Security personnel. These areas shall also cater to local storage and space for maintenance personnel to work.

Maintenance Philosophy for signaling systems

The philosophy of continuous monitoring of system status and preventive & corrective maintenance of Signaling and telecommunication equipments shall be followed. Card / module / sub-system level replacement shall be done in the field. Maintenance personnel shall be suitably placed at intervals and they shall be trained in multidisciplinary skills. Each team shall be equipped with a fully equipped transport vehicle for effectively carrying out the maintenance from station to station. The defective card/ module / sub-system taken out from the section shall be sent for diagnostic a centralized S&T repair lab suitably located on the section. This lab will be equipped with appropriate diagnostic and test equipments to identify the faults and undertake minor repairs. Cards / modules / equipments requiring major repairs as specified in suppliers documents shall be sent to manufacturer's workshop.

9.16- Telecommunication

The telecommunication system acts as the communication backbone for Signaling systems and other systems such as SCADA, AFC etc and provides telecommunication services to meet operational and administrative requirements of metro network.

Overview

The telecommunication facilities proposed are helpful in meeting the requirements for,

- Providing back bone for the Signaling system for efficient train operation.
- Exchange of managerial information.

- Passenger information system.
- Crisis management during emergencies.
- The proposed telecom system will cater to the following requirements.
- Train Traffic Control.
- Maintenance Control.
- Emergency Control.
- Station to station dedicated communication.
- Telephone Exchange.
- Integrated Passenger Announcement System and Passenger Information.
- Display System within the station and from Central Control to each station.
- Centralized Clock System.
- Instant on line Radio Communication between Central Control and Moving Cars and maintenance personnel.
- Data Channels for Signaling, SCADA, Automatic Fare Collection etc.
- E&M SCADA and Access Control is not envisaged as part of Telecomm System.

Telecommunication System and Transmission Media

Fiber Optic System (FOTS) - Main Telecommunication Bearer

The main bearer of the bulk of the telecommunication network is proposed with optical fibre cable system. Considering the channel requirement and keeping in view the future expansion requirements a minimum 48 Fibre optical fiber cable is proposed to be laid in ring configuration with path diversity.

SDH (STM-16) based system shall be adopted with SDH nodes at every station and OCC. Access 2MB multiplexing system will be adopted for the lower level at each node, equipped for channel cards depending on the requirement of channels in the network. Further small routers and switches shall be provided for LAN network at stations. Additionally totally IP Based High Capacity, highly reliable and fault tolerant, Ethernet Network (WAN/LAN) shall be provided for data intensive sub-systems like CCTV, SAP, etc.

Telephone Exchange

For an optimized cost effective solution, extension for telephonic communication up to 30 ports shall be planned at each station. The Exchanges at Central Control and Depots shall be of larger sizes as per the actual number of users. The Exchanges will serve the subscribers at all the stations and Central Control. The exchanges will be interconnected at the channel level on optical backbone. The exchanges shall be software partitioned for EPABX and Direct Line Communication from which the phones shall be extended to the stations.

Mobile Radio Communication

Mobile Radio communication system having up to 8 logical channels is proposed for online emergency communication between Motorman (Front end and Rear end) of moving train and the Central Control. The system shall be based on Digital Trunk Radio Technology to TETRA International standard. All the stations, DCC and the OCC will be provided with fixed radio

sets. Mobile communication facility for maintenance parties and Security Personnel will be provided with hand-held sets. These persons will be able to communicate with each other as well as with Central Control.

- To provide adequate coverage, the RF site survey to be carried out during detailed Design stage. Base stations for the system will be located at sites conveniently selected after detailed survey. Tentatively minimum 1 BTS shall be positioned every third station. The frequency pairs shall require concurrence of WPC.
- In addition to the TETRA Radio Coverage for the internal critical use of the Metro, GPRS/CDMA Mobile should be used for O&M activities.
- It is expected that coverage shall be available from the adjoining sites of the Mobile Operators.

Passenger Announcement System

The System shall be capable of announcements from the local station as well as from OCC. Announcements from Station level will have over-riding priority in case of emergency announcements. The System shall be linked to Signaling System for automatic train actuated announcements.

Passenger Information Display System

These shall be located at convenient locations at all stations to provide bilingual visual indication of the status of the running trains and will typically indicate information such as destination, arrival/departure time, and also special messages in emergencies. The boards shall be provided at all platforms and concourses of all stations. The System shall be integrated with the PA system.

- The OCC will be located in the Depot. The ground floor will accommodate S&T Equipment and UPS. First floor will be used for OCC Theatre. At the OCC, the areas required shall be:
- For OCC theatre- 250 sq. m.
- Signal and Telecom equipment room at OCC: 250 sq. m.
- Central computer and NMS for AFC system: 100 sq. m.
- Communication System supervisor - 36 sq. m.
- UPS room at OCC: 50 sq. m.
- Space for S&T spares storage in depot: 100 sq. m.
- The Depot control centre (DCC) equipment will be co-located with S&T equipment at OCC. DCC will be accommodated in the OCC theatre.
- All the rooms will be air-conditioned. The OCC theatre will also accommodate CCTV monitoring by Security personnel. These areas shall also cater to local storage and space for maintenance personnel to work.

Centralized Clock System

This will ensure an accurate display of time through a synchronization system of slave clocks driven from the existing Master Clock at the Operation Control Center. The existing master

Clock shall be expanded to cater for this. The Master Clock signal shall also be required for synchronization of FOTS, Exchanges, Radio, Signaling, etc. The System will ensure identical display of time at all locations. Clocks are to be provided at platforms, concourse, Station controller Room, Depots and other service establishments etc.

Closed Circuit Television (CCTV) System

The CCTV system shall provide video surveillance and recording function for the operations to monitor each station. The monitoring shall be possible both locally at each station in SCR and remotely from the OCC. CCTV System shall be provided for platforms and station building entrances for all station with 10 Cameras per station. The exact number of Cameras may slightly vary and will be decided based on station layout. The CCTV system backbone shall be based on IP technology and shall consist of a mix of Fixed Cameras and Pan/Tilt/Zoom (PTZ) Cameras. Cameras shall be located at areas where monitoring for security, safety and crowd control purpose is necessary.

Network Monitoring and Management

For efficient and cost effective maintenance of the entire communication network, it is proposed to provide a network management system (NMS), which will help in diagnosing faults immediately from a central location and attending the same with least possible delay, thus increasing the operational efficiency and reduction in manpower requirement for maintenance. The proposed NMS system will be covering Radio communication, Optical Fiber Transmission, Telephone Exchange and summary alarms of PA/PIDS, CCTV and Clock System. PTCC (Power and Telecom Co-ordination Committee) clearance would be required for resolving power and telecom lines issues before commissioning.

Technology

The Technologies proposed to be adopted for telecommunication systems are shown in Table below:

System	Standards
Transmission	Optical Fibre system as the main bearer for bulk of the telecommunication network.
Telephone change	EPABX extensions up to 30 ports are to be provided at
Train Radio System	each Station. Digital Train radio (TETRA) communication between motorman of moving cars, stations, maintenance personnel and central control.
Train Destination Indicator System	LED/LCD based boards with adequate visibility to be provided at convenient location at all stations to provide bilingual visual indication of the status of the running trains, and also special messages in emergencies.
Centralized clock system	Accurate display of time through a synchronization system of slave clocks driven from a master clock at the OCC and sub – master clock in station.

	This shall also be used for synchronization other systems.
Passenger Announcement System	Passenger Announcement System covering all platform and concourse areas with local as well as Central Announcement.
Redundancy (Major System)	Redundancy on Radio's in the Base Stations,Path Redundancy for Optical Fibre Cable by provisioning in ring configuration.
Environmental Conditions	All equipment rooms to be air-conditioned.
Maintenance Philosophy	System to have, as far as possible, automatic switching facility to alternate routes/circuits in the event of failure. Philosophy of preventive checks of maintenance to be followed. System networked with NMS for diagnosing faults and co- ordination. Card/module level replacement shall be done in the field and repairs undertaken in the central laboratory/manufacture's premises.

Space Requirement for Telecom Installations

Adequate space for proper installations of all Telecommunication equipment at each of the stations has to be provided keeping in view the case of maintenance and use of instrumentation set up for regular testing and line up of the equipment/system. The areas required at each of the stations for Telecom equipment shall be 40 Sq. m. for Telecom Room and 50 Sq. m. for UPS Room (common for signal, telecom and AFC).These areas shall also cater to local storage and space for maintenance personnel to work. At the OCC, the areas required shall be as per the final configuration of the equipment and network configuration keeping space for further expansion

9.17- Automatic Fare Collection

Introduction

Monorail Systems handle large number of passengers. Ticket issue and fare collection play a vital role in the efficient and proper operation of the System. To achieve this objective, ticketing system shall be simple, easy to use/operate and maintain, easy on accounting facilities, capable of issuing single/multiple journey tickets, amenable for quick fare changes and require overall lesser manpower. In view of above, computer based automatic fare collection system is proposed. For Multiple Journey, the Store Value Smart Card shall be utilized and for the Single Journey, the media shall be Contactless Smart Token. AFC system proves to be cheaper than manual system in long run due to reduced manpower cost for ticketing staff, reduced maintenance in comparison to paper ticket machines, overall less cost of recyclable tickets (Smart Card) in comparison to paper tickets and prevention of leakage of revenue. The AFC equipment shall be provided at each station at convenient locations and will be connected to a local area network with a computer in the Station Master's room.

Auto Top Up Through Debit Card

The commuter will apply for registration of his account by mentioning his details as well as card engraved ID. The account will be activated after due verification from the bank and card data base by the AFC system. Now the user will be able to use this account tomake 'add value' in his AFC card and the transaction can be carried out from the debit card through the bank payment gateway. The AFC card will get charged whenever the user shows his card at nominated AFC equipment at station.

Choice of Control Gates

Retractable flap type Control Gates are proposed which offer high throughput, require less maintenance and are latest in modern metros internationally. Tripod turnstile type gates offer less throughput and require more maintenance and hence are not proposed.

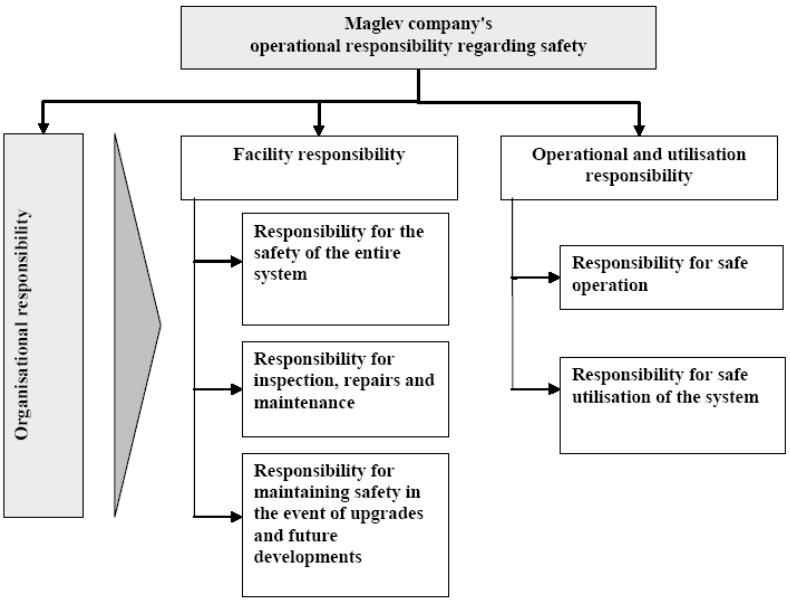
Passenger Operated Machine

At all stations, minimum two Passenger Operated Machines (Automatic Ticket Vending /Add Value Machines) each are proposed. The POM's will provide convenience to passengers to avoid standing in queues at ticket booths and provide them international level service.

9.18-Safety & Security

Safety concept

Despite high speeds, passengers are safer in maglev vehicles than in other transportation systems. The electromagnetically suspended vehicle is wrapped around the guideway and therefore virtually impossible to derail. Elevated guideways ensure that no obstacles can be in the way. Maglev Magnetic Two-tier Monorail systems are required by law to guarantee construction and operation of a system that meets proper safety standards. The responsibility of Maglev Magnetic Two-tier Monorail systems are schematically shown in Fig.



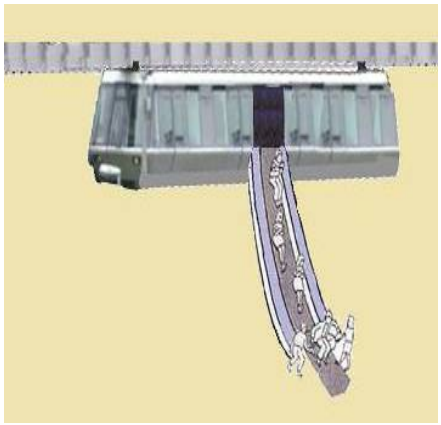
Rescue concept

An essential component of the safety concept is the rescue concept. The Maglev Magnetic Two-tier Monorail vehicle operator has to explain in this concept with which measures self and external rescue shall be guaranteed. Depending on conception self and/or external rescue measures require different sizes of escape routes, places for emergency stops and accessibilities. Therefore, the rescue concept influences the extent of the required properties so that the effects on the planning approval procedure are given immediately. The examples of protection against going off and rescue concept clearly show how safety concept and planning approval are connected with each other. This means that the development of a safety concept must be at the beginning of the planning process of a Maglev Magnetic Two-tier Monorail system. However, changes of the route course may occur because of others than for safety reasons, so that corresponding customizations of the safety concept can become necessary at a later date.

The factors affecting transportation safety and security are various, among which, the physical structure and guideway security patrols play significant roles. Elevated guideways can be operated safety and efficiently. A means will be required to transfer passengers from the emergency walkway to the ground unless rescue vehicles are used to remove passengers from the walkway. The proposed method of egress from the emergency walkway is a pair of hinged stairways located within one guideway span where the walkway beam would be discontinuous. The stairways would be hinged at the end of the walkway beam and would be attached to dampers that would control the lowering of the stair. The passengers would need to activate a manual release mechanism and then the stair would lower by gravity, slowed by the dampers. The stairways would need to be located at intervals that are a reasonable walking distance.

Passenger Safety and Evacuation

The puduvai trans will be fully automated (no drivers) with central control from facilities adjacent to the guideways. Security personnel, by means of audio-visual communication, would view the vehicles inside at all times, during unloading and loading as well as while traveling on the guideway. Laser beams on-board the vehicle will control any irregularities or emergencies on the guideway and bring the vehicle to a stop if needed. Special vehicle escape devices i.e. each car contains a provision wherein an emergency slide way passage is in-built for the passengers to evacuate (as shown in the figure) from elevated guideways.



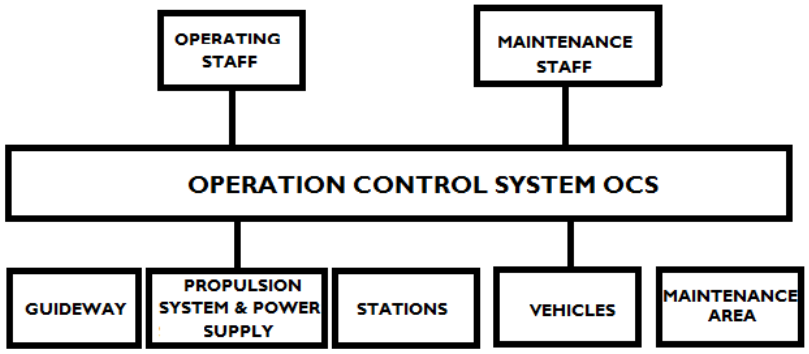
Operation control system (OCS)

The OCS comprises all technical facilities for planning, monitoring and safeguarding of vehicle operation which means a combination of automatic vehicle operation (ATO) and automatic vehicle protection (ATP) functions like e.g. providing a safe vehicle travel path in order to avoid collisions and the monitoring of vehicle travel speed range in order to assure stopping only at

predefined stopping points. The OCS consists of central, wayside and mobile components with interactions to other sub-systems respectively operational and maintenance staff.
The structure of the OCS is as shown below.

Operation control system (OCS) is the part of an overall Maglev Magnetic Two-tier Monorail system that integrates all subsystems like operation control center, guideway elements, stations, maintenance areas, propulsion and power supply, and vehicles. An OCS contains all components and functions to control and monitor the safe Maglev Magnetic Two-tier Monorail operation. OCS allows control of the vehicle movements and guideway elements both manually and automatically. On the base level, OCS provides all the safety functions generally known in railway signaling, e.g. vehicle locating, guideway switch control, route protection (interlocking), and automatic vehicle control including speed monitoring.

Functonal Block Diagram of OCS



Reliability, availability, maintainability and safety

An important issue in the proper operation of rapid transit systems is the reliability, availability, maintainability and safety (RAMS). RAMS is the item that needs to be considered in any new rapid transit system establishment. This item is the factor that affects the passenger's mode choice decisions and is important for project evaluation.

Maglev Magnetic Two-tier Monorail is one of the safest means of transportation in the world. The concept of Maglev Magnetic Two-tier Monorail has essentially eliminated the safety risks associated with the operation of conventional rail systems. The use of a dedicated and separated guideway without intersections with other transportation modes such as roads and highways ensures no safety conflicts and allows uninterrupted Maglev Magnetic Two-tier Monorail operations. The Maglev Magnetic Two-tier Monorail technology has essentially eliminated the safety risks associated with the operation of rapid transit systems. Compared to the operating experiences of conventional railway system, the Maglev Magnetic Two-tier Monorail technology has a scarce record.

eEnergy consumption and space requirement

With non-contact technology, there is no energy loss due to the wheel-guideway friction.

The vehicle weight is lower due to the absence of wheels, axles and engine (low mass of approx. 0.5 t per seat). In terms of energy consumption, the Maglev Magnetic Two-tier Monorail vehicles are better than conventional trains. As consumers of energy, the transportation sectors are vulnerable to environmental and global warming concerns and the increasing volatile oil market. Reducing dependency on foreign oil is also an important criterion. The system of the external power supply over the contact rail causes higher investment and operational costs.

Pollution

As Maglev Magnetic Two-tier Monorail is electrically powered, there is no direct air pollution as with airplanes and automobiles. The Maglev Magnetic Two-tier Monorail causes lower CO_2 emissions. It is also easier and more effective to control emissions at the source of electric power generation rather than at many points of consumption. Maglev Magnetic Two-tier Monorail is the quietest transportation system available today. Due to its non-contact technology, there is neither rolling nor gearing or engine noise. The frictionless operation of the Maglev Magnetic Two-tier Monorail vehicle reduces vibration and maintenance resulting from wear.

Loading

In this part of research, Maglev Magnetic Two-tier Monorail guideways and road and railroad bridges are compared from loading and design aspects. The optimal design of all bridges, including road, railroads and Maglev Magnetic Two-tier Monorail elevated guideways is really vital. Majority of the existing Maglev Magnetic Two-tier Monorail guideways are elevated and completely built on the bridge. In fact, a Maglev Magnetic Two-tier Monorail elevated guideway is one kind of bridges. Therefore, it can be compared with any bridge, including railroad and road.

Customer Safety and Security

Customer safety and security will be of prime importance for all aspects of the ***Puduvai Trans*** operation. Passenger safety must be all-encompassing from the fundamentals of design through to the fire alarm system, signaling system and rolling stock. Stations and other public areas will give people a sense of safety and security by incorporating light and open spaces into relevant designs. Crime Prevention through Environmental Design (CPTED) principles will be employed to reduce the levels of crime and help to provide a safe environment. Customer safety and security will be achieved through a combination of proven station and rolling stock design, fully integrated systems and a safety management policy that ensures:

- All staff are trained to deal with a wide range of situations and emergencies,
- Station and train staff maintain a high level of visibility to provide customer confidence,
- Good use is made of the equipment available e.g. the ticket gates are used to control crowding and the presence of CCTV is well advertised to act as a deterrent,
- Effective systems integration to promote safe operation of the Monorail,
- Operational processes that are simple to understand and implement,
- Safety targets are in line with international best practice and are systematically monitored

and managed, and

- Efficient and effective use of the Group Station Control Rooms and Operations Control Centre to co-ordinate key activities, processes and systems.

Employee Safety

Employees, contractors and Emergency Services personnel when engaged in activities on must be able to carry out their duties during normal and degraded operations without risk of injury or ill-health. This will be achieved, through risk reduction and harm minimization processes, safe systems design and safe operating practices. Staff training will ensure that personnel understand their duty of care to themselves and others. It will also equip them to deal with conflict and deal with aggressive behavior. In the event that the On Train Customer Service Assistant has to drive the train, a protected area will be provided to segregate the Assistant and reduce risk of interference and distraction while in control of the train.

Group Station Control Rooms

The current station system architecture and design has been developed using the foreign model of Group Station Control rooms, where one control room monitors typically 3 or 4 stations. This provides ability for local control and monitoring of station plant and equipment of adjacent stations and a back up facility to the OCC if required. The control room staff will be able to respond to incidents such as people stuck in a lift, but their time away from the control room will be limited. There is an opportunity to explore an alternative arrangement with control from the OCC supported by a single back-up station control room. This avoids the need to resource multiple station control rooms and will be further investigated during concept design.

Safety And System Assurance

A suite of Key Performance Indicators will be developed to cover the following areas and deliver a culture of continuous improvement:

- Customer Complaints per thousand journeys,
- Customer Satisfaction (survey results),
- Station and train cleanliness and presentation,
- Levels of ticket less travel, gating and ticket machine availability,
- Quality of manual announcements on station and on train,
- Punctuality, reliability and passenger delays,
- Infrastructure punctuality and reliability impacts,
- Staff availability and attitude,
- Patronage,
- **Puducherry** maps of the stations available on request, and
- Audible announcements of the next train and the destination

Customer Service Center

Given the size of, it is not practical to set up a bespoke customer service centre. It is therefore proposed that this function and that of lost property is contracted out to a specialist customer

contact handling and lost property company and that the service is paid for per contact/ per item basis. Customers will also be able to obtain information from the Transport Info line.

The Operations Controller will be responsible for providing up to date information to the website, Info line and customer contact handling company. The Customer Service Managers will also assist the contact handling company with complaints. The customer contact centre will be available 07:00-19:00 Monday to Friday and 08:00 – 16:00 on Saturdays, Sundays and all Public Holidays except Festival season. A recorded message service is available outside of these hours. Details of opening hours and contact details will be made available on train, at stations and on the website. Customers will be encouraged to email or call the centre as opposed to writing in to ensure a rapid response. Customer complaint targets will be developed and senior managers within the business will be encouraged to review complaint summary reports and 10% of complaints each period to understand the nature of the service failures and to implement corrective actions

Communications

DC Substation entry alarm monitoring and equipment panel door monitoring
The general philosophy is that all systems can be monitored at the OCC but only those systems that are operationally critical (which includes those that are safety critical) would be controlled from the OCC. Control of non-operationally critical systems would reside locally at station, group station control rooms (GSCRs) and/or infrastructure locations. Systems monitoring and control within the OCC will be the responsibility of a single “Technical Controller”. This function will be discrete (and at a separate workstation) from any Train Control function. The role will also undertake condition monitoring of rolling stock. Stations and other infrastructure locations will have appropriate local control panels but these will not be actively monitored locally. Monitoring of groups of stations will rest with the GSCRs

The ***Puduvai Trans*** is an enabling element for a network. Its capacity is defined by the ability to cater for future extensions and the requirement to carry the morning and afternoon peak demand in both directions through. Considerations of future capacity requirements and alignment extensions have shown that a single-bogies train set is the optimal solution. This is to provide capacity for 50 passengers. The peak frequency of services is anticipated to be 10 trains per hour, moving to 10 trains per Customer ease of use will be a priority on a number of levels

- Readily available information will be provided regarding services and amenities in the station environs.
- A simple way-finding policy will deliver signage that is clear, easy to read and caters for all modes of arrival at the station, a range of languages spoken and impairments. Advertising, retail and non-essential signage will not impair way-finding.
- Customers with reduced mobility will be able to access and use the station independently through the provision of lifts.

Accessing the ***Puduvai Trans*** Convenient access and interchange is critical to success. The stations will be safe, well lit and visually appealing. Each station will be designed for easy access, providing access for pedestrians and cyclists with appropriate bicycle storage, and interchange

to rail and/or bus. The stations will also improve connectivity with the local amenities within the ***Puduvai Trans*** boundaries. It will have a strong brand presence based on the Product Principles that distinguish them from other forms of transport whilst demonstrating strong connectivity with existing services. As part of that brand the ***Puduvai Trans*** will have a distinctive and recognizable image and livery. The pricing policy and ticketing system will be easy to understand and simple to use for all types of customers. Clear information will be provided on how to access.

Supervisory Control and Data Acquisition of Systems (SCADA)

SCADA is the acronym for **Supervisory Control and Data Acquisition**. SCADA is a computer-based system for gathering and analyzing real-time data to monitor and control equipment that deals with critical and time-sensitive materials or events. SCADA systems were first used in the 1960s and are now an integral component in virtually all industrial plant and production facilities.

We make use of this technology for Electrical power transmission and distribution. The main requirement of these devices includes monitoring equipment voltage and current.

SCADA systems utilize Distribution Control Systems (DCS), Process Control Systems (PCS), Programmable Logic Controller (PLC) and Remote Terminal Units (RTU) that perform the majority of local and remote process alarming, monitoring and control.

There will be a fully integrated approach in respect to the installed systems on the

- ***Puduvai Trans*** will be a common platform which would allow control and Monitoring from generic operator workstations. Some examples of the types of systems to be integrated that includes ATO/ ATP systems,
- Bulk supplies, HV reticulation, traction supplies, general M&E power supplies,
- Station systems such as lifts, air conditioning, power supplies, pumping, fire systems,
- Lighting,
- Automatic ticket gates,
- Performance monitoring systems (or modules attached to other systems)
- Incident reporting and monitoring systems (e.g. passenger injuries, assaults operational incidents).

In addition, SCADA systems are needed to monitor and control a large geographical displacement where an organization may not have enough manpower to cover. Thus, reliable communication and operability of these areas or sites is critical to profitability.

The SCADA system shall record any events caused by faults, malfunctions, warnings or alarm information generated automatically by the selected equipment.

A central recording system shall be provided to record the following events.

- Change of state of RTU input parameters,
- events designated as alarms,

- faults,
- control actions, and
- System generated messages, e.g., equipment malfunction etc.

10.0-Funding

Many FOREIGN investors are willing to be a part of this highly innovative transportation project to be implemented in India. The one being "IAT - Innovative Assess Team", based in Germany.

They have the patent rights for the Maglev Magnetic two-tier Monorail system.

They will possibly be our infrastructure partner for the project.

10.1-Cost Estimate

Cost of civil structures has been estimated based on Puducherry State PWD schedule ofrates (revised 2010) which came into effect from 01.04.2015. The total cost of the projectbased on April 2015 price level works out to Rs 893 crores excluding taxes of Rs 255crores. he completion cost of this project comes to Rs. 1148 crores with central taxes.

Admin executive's expenses

DGM (Material Management)	49800	36	1792,800
Manager (Administration)	45000	36	1620,000
Manager (Training Institute)	45000	36	1620,000
Manager (OCC)	45000	36	1620,000
Asst. Chief Controller	34800	36	1252,800
SectionEngineer (Electrical/Mechanical/Civil/Electronics)	30000	36	1080,000
Section Engineer – Stores	30000	36	1080,000
Crew Controller/Line Supervisor	30000	36	1080,000
Train Operator /Train Instructor	18000	36	648,000
Superintendent – (HR & Admn)	18000	36	648,000
Assistant - HR	12000	36	432,000
Assistant - Accounts	12000	36	432,000
Store Keeper	12000	36	432,000
Total			13,737,600

Expenses

SL			Quantity		No	Net value
1	*Land*					
	Land Area Cost A – Ground space	4,800	5,000	24,000,000	16	3,84,000,000
2	*Alignment And Formation*					
	Elevated Pillar	6,000,000	573			3,438,000,000
3	*Station Buildings*					
	Station Construction A Side (4800*3)	14,400	3,000.00	43200000	16	6,91,200,000
4	E & M Works					
	Lifts A & B Stations with lifts and escalators	9,000,000	16			144,000,000
5	Depot					
	Depot Land - Free	-	-			-
	Civil Cost	-	-			800,000,000
6	Switches					
	Only Switches (Mainline) Including Motor Stools	700,000	3.00			2,100,000
	Traction & Power Supply Incl. Elevated	20,000,000	17.200			34,40,00,000
7	*Signaling & Telecom*					
	Signaling	900,000	17.200			15,480,000
	Telecom	300,000	17.200			5,160,000
	Automatic Fare Collection	230,000	16			3,680,000
	Guideway metal fixing	10,000	17,200			172,000,000
	Guideway metal Frame	2,000,000	573			1,146,000,000
	Solar Panel	20,000	17.200			344,000,000
8	Road Restoration Etc.	100,000	16.00			1,600,000
	Generator	4,03,00,000	16.00			4,03,00,000
9	Misc. Utilities, Other Civil	200,000	16.00			3,200,000
	Electrical Utilities					100,000,000
10	Rolling Stock Required For This Extension	80,000,000	Each	12		960,000,000
11	*Staff Quarters For O&M*					
12.	Labor Salary In 24 Months	500	300.00	3	365	1,642,50,000
13.	Admin executives Salary					13,737,600
	Project net cost					8,672,707,600
	Contingencies @ 3 %					260,181,228
	With Contingencies					8,932,888,828

After the completion the project expenses

Particulars	No.of persons	Expenses	Sub station	Total	Months /Days	Total
Salary	10	20,000.00	17	34,00,000.00	12	4,08,00,000.00
repairs& Maintenance		40,000.00	17	6,80,000.00	12	81,60,000.00
Electricity		50,000.00	17	8,50,000.00	12	1,02,00,000.00
Other Expenses		25,000.00	17	4,25,000.00	12	51,00,000.00
Total				**53,55,000**		**6,42,60,000**

After the completion the project revenue

Train per hr	Station	Average Occupancy	No. of ways of each train per day	Average Fare	Fare revenue per day	No. of days	Yearly revenue
10	16	100	2	30.00	9,60,000.00	365	35,04,00,000
					9,60,000.00		**35,04,00,000**

Advertisement Revenue

No. Of Stations	No. Of Advertisement	No. Of Trains	Charge Per Ad	Revenue Pm	No. Of Months	Annual Revenue
16	3	0	5000	240,000.00	12	**2,880,000**

ATM space in station Revenue

Total No. Of Atm	Rent Per Month	Rental Income P.M.	Months	Rental Income P.A.
5	10,000.00	50,000.00	12	600,000.00

Shops

Total No. Of Stations	RentPer Month	No. Of Shops	Rental Income P.M.	Months	Rental Income P.A.
16	5,000	3.00	240,000.00	12	**2,880,000**

Station income

Details of Taxes and Duties

Details of Taxes and Duties	Total cost without Taxes & duties (Cr.)	22.85%	12.50%	14.00%
Description		***Customs***	***Excise***	***VAT***

Elevated Pillar	344.00		429750000	481,320,000
Station Construction	69.20		86400000	96,768,000
Lifts and escalators	14.50	32908464	18000000	20,160,000
Depot Civil Cost	80.00		100000000	112,000,000
Only Switches Including Motor Stools	0.21	479915.1	262500	294,000
Elevated	35.00	78614664	43000000	48,160,000
Signaling	15.50	3537659.88	1935000	2,167,200
Telecom	0.52	1179219.96	645000	722,400
Automatic Fare	0.37	840994.08	460000	515,200
Guideway metal fixing	17.20	39307332	21500000	24,080,000
Guideway metal Frame	115.00	261896526	143250000	160,440,000
Rolling Stock	96.00	219389760	120000000	
Total	**787.50**	**638,154,535**	**965,202,500**	**946,626,800**
Tax only				**2,549,983,835**

INR & $

Cost Estimate	***INR***	***$***
Total Cost	8,932,888,828	142,252,547
Admin executive's expenses	2,187,666	13,737,600
After the completion the project expenses	6,42,60,000	1,023,143
After the completion the project revenue	35,04,00,000	*5,579,135*
Advertisement Revenue	2,880,000	*45,839*
ATM space in station Revenue	600,000	*9,553*
Shops	2,880,000	*45,839*
Details of Taxes and Duties	2,549,983,835	*40,605,160*
Total project cost	***INR 1,148,000,000***	***$ 182,790,610***

Passenger Planning Assumptions

Train Composition :	Single car
Passenger Carrying Capacity (@ 6 persons per square meter of standee area	Approx. in the range of 100 to 108.
Passenger Carrying Capacity (@ 8 persons per square meter of standee area)	Approx. in the range of 130 to 145.
(ii) Coach requirement has been calculated based on headway during peak hours. (ii) Coach requirement has been calculated based on headway during peak hours. (iii) Traffic reserve is taken as one train to cater to failure of train on line and to make up for operational time lost.	

(iv) Repair and maintenance reserve has been estimated as 8 % of total requirement (Bare +Traffic Reserve).
(v) The calculated number of rakes in fraction is rounded off to next higher number.
(vi) Schedule speed is taken as 30 kmph.
(vii) Total Turn round time is taken as 6 min at terminal stations.

Planning Assumptions

Note 1: No. of persons per Sub – Station.
Note 2: Total Salary cost of all Sub – Station (B*C*D).
Note 3: No. of persons per Terminal and Main Station / Cost per Terminal and Main Station.
Note 4: No. of Months / Days.
Note 5: (E+G)*H.
General Note: 1) The above expenses are exclusive of INTEREST cost.
2) A, B, C, D, E & F = Assumptions for calculations.

Please note that these cost estimates are based on the following planning assumptions.

Trains and Control Systems

Four-minute train frequency at peak hours, eight-minute train frequency at nonpeak times, a Smart Card fare collection system, and fully automated operations.

Beams, Columns, Foundations

Seventh five-mile guideway with columns that are narrower and spaced farther with funds to improve column appearance. Emergency walkway along the guideway, premiums for nighttime construction to minimize construction impacts on nearby properties and streets, and staging tracks at which trains could be held ready during major events

Water Crossings

Only One Canal Is a Water Crossing.

Maintenance Facility

Basic design and function, and co-location of control center, maintenance facility, and headquarters in the same building.

Utilities

All utility relocation costs and some undergrounding of electrical wires are given to a division of actual relocation work between the City and private contractors.

Rights of Way

Market value paid on the limited number of properties that must be acquired, some easements to be purchased, and high-value properties resold when construction is completed.

Power Supply

Puduvai Trans provides energy efficient transit and power solutions to reduce costs and increase air quality, safety, and connectivity using sustainable energy. The Maglev Magnetic Two-tier Monorail and overhead suspended light rail Monorail system offers safety, reliability and evacuation in emergencies. It also provides high speeds, at a low cost, with minimal disruption to the natural environment. The integrated transport maglev magnetic Monorail approach, which composes of pre- and on-carriage for collection and delivery, terminal operation and main haulage including the management of the whole chain. Technical aspects takes into consideration the innovations developed by the Partners. This regards transshipment systems and advanced handling, terminal management and identification, location & positioning techniques, rolling stock design.

Design and Administration

Covers all design work, bonding and insurance, contractor profits, needed overhead and administrative costs, and a public art program. Assumes that work would be completed by union contractors paying living wages to their workers, and that a comprehensive labour agreement would be developed. The cost estimate proposed by the UITPI includes a contingency for each item in the budget. These contingencies were set at different levels depending on the level of certainty or uncertainty of each item's cost. The contingency for trains and control systems, for example, is only 5%, as the cost to construct train cars and control systems is relatively certain

Reserve for construction escalation

The costs listed above have been estimated in 2015 dollars i.e. 1$ = INR 62. However, inflation over time means that the costs of labor and materials will rise each year. This reserve provides a fund that was estimated based on the region's construction cost inflation level.

Train frequency

17 hours per day, seven days per week, approximately 6 minutes between trains during peak periods (3 hours in both morning and afternoon) and special events, approximately 8 minutes between trains during non-peak periods (remaining weekday hours, weekends, holidays).

Pre-construction planning/design

During the time before procurement documents for a design-build contract can be issued, the ***Innovative Access Team Corporation*** would be responsible for pre-design work and for conducting detailed environmental and preliminary engineering studies for the ***Puduvai Trans*** Project.

Civil Structures

The metal guide tracks, for up and down tracks, are carried over square pillars of about 1.0 diameter generally located along the median of the road. Every 30 meters each pillars and pier heads have a minimum clearance of 15 m above the road level. The single sides of stations are proposed for the project at all the facilities and technical rooms are housed outside the right of way and only platforms are provided over the road supported by pillars located on the median

of the road. The access to the station is provided from outside the right of way. All stations will have elevators for old and physically challenged persons. All stations will have fire detection and fire fighting arrangements as prescribed in the National Building Codes.

Minimum distance between track magnetic guide centers has been kept as 5 meter. On curves, distance has been increased based on the additional clearances needed for mid throw and end throw as well as for super elevation. The maximum distance between the track magnetic guide beams on a curve of radius of 30 m has been found to be 4.4 m. The minimum radius adopted for the track alignment is 40 m and maximum gradient for the vertical alignment is 6%. Proper transition curves for the horizontal and vertical curves as well as cants and cant-deficiencies have been worked out and provided as per the best international practices.

The cost for civil structures has been worked out based on Puducherry State PWD schedule of rates (revised 2010) which came into effect from 01.04.2011
Estimate details are furnished below:

Viaduct Civil Structures

Sl.	Item	Quantity/km	Rate in INR	Unit	Amount in INR
1	Pier cap (m 40)	241.54	28562	1 cum	68, 98, 865
2	Pier (m40)	374.85	20909	1 cum	78, 37, 739
3	Pier (m35)	2616.67	19008	1 cum	497, 37, 663
4	Superstructure (m50)	2857.95	28562	1 cum	816, 28, 768

Reinforcement Concrete items

1	Pier cap (m 40)	43.48	97383	1 MT	42, 34, 213
2	Pier (m 40)	74.97	97383	1 MT	73, 00, 804
3	Pier (m 35)	418.67	97383	1 MT	407, 71, 341
4	Superstructure (m 50)	314.37	97383	1 MT	306, 14, 294
5	Prestressing steel	157.19	207859	1 MT	326, 73, 356

10.2-Financial Viability, Fare Structure And Financing Options

Introduction

The Two-tier Maglev Magnetic Mono Rail covering a route length of 17.200 m is proposed to be constructed from jan-2016 to July-2019. The fixed cost at March-2015 prices is estimated to be of Rs.893 Crores including the cost of land but excluding taxes and duties. The estimated cost including Central taxes and duties is Rs.1148 Crore.

Costs

Investment Cost

For the purpose of calculating the Financial Internal Rate of Return (FIRR), the completion cost with central taxes of Rs.1148 Crore has been taken as the initial investment.

- The construction is expected to be completed by Dec-2018, and accordingly the cash flow has been worked out.
- The land cost is divided into three initial years during which it is expected that the land acquisition work would be over and related payments would have to be released.
- The escalation factor used is 5% p.a.

Additional Investment

The above table depicts the change in the growing population in the years to come will definitely pave way for the increase in the rail cars. The new rail cars will be bought by the revenue generated by the Maglev monorail system itself. The frequency between two rail cars will be 6 minutes. When the time duration is reduced to 3 minutes, additional rail cars will be bought. The cost of per rail car is 8 crores. Depending upon the population, the remaining new cars will be purchased.

Operation & Maintenance Costs

The Operation & Maintenance costs can be divided into three major parts:

- Staff costs.
- Maintenance cost which include expenditure towards upkeep and maintenance of the system and consumables.
- Energy costs.

The staff is assumed to be provided @ 10 persons per kilometer. The escalation factor used for staff costs is 9% per annum to provide for both escalation and growth
in salaries. The cost of other expenses is based on the O&M unit cost expected for the Delhi Metro project. The rate of electricity assumed is about Rs. 4.00 per unit and the same has been used for all calculations. The O&M cost (excluding staff cost) has been obtained by providing an escalation of 5% per annum.

Operation and Maintenance

The year-wise O&M costs are as indicated in Table below (Rs./Crore)

YEAR			Staff	Maintenance Expenses	Energy	Total
2018	-	2019	37.00	19.00	9.00	65.00
2019	-	2020	40.00	20.00	9.00	69.00
2020	-	2021	44.00	21.00	10.00	75.00
2021	-	2022	48.00	22.00	11.00	81.00
2022	-	2023	52.00	23.00	12.00	87.00
2023	-	2024	57.00	24.00	13.00	94.00
2024	-	2025	62.00	25.00	14.00	101.00

2025	-	2026	68.00	26.00	15.00	109.00
2026	-	2027	74.00	27.00	16.00	117.00
2027	-	2028	81.00	28.00	18.00	127.00
2028	-	2029	88.00	29.00	19.00	136.00
2029	-	2030	96.00	30.00	21.00	147.00
2030	-	2031	105.00	32.00	23.00	160.00
2031	-	2032	114.00	34.00	24.00	172.00
2032	-	2033	124.00	36.00	26.00	186.00
2033	-	2034	135.00	38.00	28.00	201.00
2034	-	2035	147.00	40.00	30.00	217.00
2035	-	2036	160.00	42.00	33.00	235.00
2036	-	2037	174.00	44.00	36.00	254.00
2037	-	2038	190.00	46.00	38.00	274.00
2038	-	2039	207.00	48.00	42.00	297.00
2039	-	2040	226.00	50.00	45.00	321.00
2040	-	2041	246.00	53.00	49.00	348.00

Depreciation

Although depreciation does not enter the FIRR calculation (not being a cash outflow) unless a specific depreciation reserve fund has been provided, in the present calculation, depreciation calculations are placed for purpose of record. These are taken @ 3% of the total completion cost adjusted for land cost.

Replacement Cost

The replacement costs are provided for meeting the cost on account of replacement of equipment due to wear and tear. With the nature of equipment proposed to be provided, it is expected that only 50% of the Signalling and Telecom and 25% of electrical works would require replacement after 20 years. Further, 50% of the Signaling and Telecom and 25% of electrical works would require replacement after 30 years. These costs have been provided duly escalated @ 5% per annum.

Fare Box Revenue Traffic

The projected traffic/Day is shown in the growth rate for traffic is assumed at 2.75% per annum up to 2021-22, 3.25% per annum up to 2031-32 and 3% thereafter.

Year	Lakhs per day
2015-16	1.48
2021-22	1.77
2031-32	2.37
2041-42	3.19

Trip Distribution

The distribution has been assumed based on the average trip length of 6.22 KMs

Distance in kms.	Distribution in 2015-16
0-2	8.00%
2-4	23.00%
4-6	30.00%
6-9	20.00%
9-12	10.00%
12-15	4.50%
15-18	2.00%
18-21	2.00%
21-24	0.50%
Total	**100%**

Fare Structure

Presently, in ***Puducherry Local Privates Buses***, the fares are charged as per the following table

Distance In Km	Fare Rs
0-2	0-5
2-4	5-7
4-6	5-7
6-9	10-15
9-12	1015
12-15	12-15
15-17	12-15

There is a discount of 10% on journey by Smart Cards. Tourist Cards @Rs.100 with a validity of 1 day. Tourist cards @ Rs. 250 with a validity of 3 days. This fare structure is as recommended by Govt. approved Fare Fixation Committee. In Delhi, the ordinary bus fare structure is as follows: Rs.5 for 0-5 km slabs and increase thereafter. The fare structure to be adopted for the Maglev Magnetic Two-tier Monorail has been based on the bus fares increased by 1½ to 2 times and somewhat matching with the fares prevailing on the Delhi Metro. While fixing the fares main considerations have been to attract passengers to Monorail and encourage long distance passengers to use this system.

Puduvai Trans Two-tier Maglev Monorail provides a reliable, safe, comfortable and fast mode of transport with air-conditioned comfort it is expected passengers will not mind paying 1½ to

2 times of the bus fares. The fares suggested as under are considered affordable to ordinary commuters.

Other Sources of Revenues

Other revenues from Property Development and advertisement have been estimated at 10% of the fare box revenues during operations. In addition, Apart from development of property on metro stations and depot it is possible to raise resources through leasing of parking rights at stations, advertisement on trains and tickets, advertisements within stations and parking lots, advertisements on viaducts, columns and other metro structures, co-branding rights to corporate, film shootings and special events on metro premises.

In addition to the above, Puducherry Municipality should collect surcharge on property taxes @20% and hand over to the Monorail Company to augment its revenues. This will fetch Rs. 3 crore per annum. A transport tax may also be levied on every employer in the city who employs more than 10 persons at a rate of 2% of their wage bill. A good public transport in the city benefits the employees substantially. This will fetch recurring revenue of Rs.5 crore per annum. Thus, total recurring incomes on these accounts have been taken @ Rs.8 crore p.a. for working out the FIRR.

Financial Internal Rate of Return (Firr)

The FIRR on the completion cost without Central Taxes and With Central Taxes is shown in table.

Particulars	Completion cost	Firr%
Completion cost with taxes	1148.00	2.72%
Completion cost without taxes	893.00	5.09%

Funding

The 1st phase of the ***Puduvai Trans*** Monorail Project at Puducherry is expected to be completed in a period of 3 years. Assuming that the project could get Government's approval and the work commence on the field by end of 2015, the completion of the project is expected by end of 2018.

Different models for financing the Project.
Possible models for financing a Mono Rail Project are –

- A Build, Operate & Transfer (BOT) model,
- A Public Private Partnership (PPP) model and

Fully through Government Funding, i.e. Government mobilizing all the funds for the project. Possibilities of these three models of financing ***Puduvai Trans*** Monorail Project are discussed below.

BOT Model

Under this model, a BOT concessionaire is selected through competitive bidding. The concessionaire brings in all the funds, appoints consultants for design, planning and project management, executes the project fully, then operates and maintains the system, collects all the revenues and at the end of the concession period, hands over the project to the owner viz the Government. Here the Government's responsibility is only to make available the required lands and right of way and monitor the quality of services and safety standards. Building the system to the required safety standards and obtaining the safety certificate from the competent authority will be the responsibility of the BOT operator. Here the Government has no financial liability and all the risks are carried by the BOT operator.

PPP Model: There Are 2 Variants Under This Model.

Variant (1)

With Government funding the fixed infrastructure such as land and basic civil structures, and a private investor funding all the system such as rolling stock, signaling, power supply, traction, track, fare collection E&M works etc including station architectural finishing. An example for this is Delhi Metro Airport line. Under this arrangement the Government's investment will be about 40% of the cost of the Project and the PPP Operator funds the remaining 60%. Under this model the concessionaire, operates and maintains the system to the required and agreed service and safety levels. All the revenues will accrue to the Operator and at the end of the concession period the project is handed over to the owner. Ridership risks are taken by the operator or shared by the operator and owner.

Variant (2)

Under this the Government acquires the required land and offers to the concessionaire free of cost. The private partner funds all the rest of the project, operates and maintains the system taking all the revenues and risks. His expected losses are made good through a Viability Gap Funding (VGF), by the Government arrived at based on competitive bidding. At the end of concession period the system reverts to the owner. Under the PPP model, Sweeteners are sometime offered to the operator in the form of lands for commercial exploitation. Private management generally ensures better efficiency in the execution and operation of the system compared to a Government agency.

The debt portion of the Project can also be covered through supplier's credit. Supplier's credit generally covers the cost of all imports such as rolling stock, signaling etc. The suppliers arrange the credits through EXIM Banks of their country and the terms offered are sometimes better than bilateral aids. Supplier's credit is a route, which can be very competitively and intelligently exploited to cover the cost of all imports and generally more advantageous than bilateral loans. Bilateral loans take a long time for negotiation and finalization whereas suppliers' credit can be finalized quickly along with tender finalization. Urban transit projects are not financially viable and have a long gestation period and therefore loans with a long tenure of 10 to 13 years are preferred. Such long tenure loans are not generally available with suppliers' credit and therefore a mechanism for recovering the loans may have to be worked out. Further the lenders will generally insist on recourse in the form of Government guarantees or escrow accounts.

Recommended Financial mode

The Monorail Project having a FIRR of 2.72% with Taxes and 5.09% without any taxes and duties will not attract any BOT operator or a PPP player. The Viability Gap Funding for PPP operator will be 85% of the project If the government is to assist 85% of the cost of the project why then at all the Government should go for private participation? The Government can as well fund the remaining 15% cost through its own borrowing. Further, the process of selecting a BOT operator or a PPP player will take anything from 18 to 24 months. Thereafter the concessionaire will take another 12 to 18 months for financial closure, to appoint consultants, finalization designs & tenders & to start physical work – a delay of 2 to 3 years. Any private operator will come forward with the objective of making huge profits and thus the ultimate cost of the project will be very high. Consequently, a higher fare Structure will be necessary to sustain the project. In a public transport system it is necessary to keep the fare levels to the affordable level of the common commuters. Therefore, in the case of Puducherry Monorail Project we do not recommend either a BOT or PPP route. To get the project executed in the shortest time possible and at the least cost the SPV route with Government funding is the best option.

SPV route and project loan

Unity Infra Transit Project Implementers the undertaken fully as a initiative and an SPV under the name "Puducherry trans rapid system" or (under any other name), may be formed fully owned by Unity Infra Transit Project Implementers.

The remaining 60% of the project cost which cover the cost of rolling stock and other systems should be funded through supplier's credit.

The finalization of bilateral loans will take nearly 3 months. The lending agencies stipulate their own guidelines for the procurements which will delay the project by 6 months. Raising loans from the local markets can be a last resort and to the minimum extent possible as such loans are very expensive. This may be still necessary to liquidate suppliers' credits. Further the private operator will insist on Government taking the ridership risks. The estimate funding under the BOT model.

1) Both governments should extend remission of taxes and duties to the project, considering its importance for technology acquisition. If this is not possible, then taxes and duties should be reimbursed to the project in the form of subordinate debt by both the Governments.

2) If Puducherry Govt. cannot impose the green tax for political reasons, then this 6% cost should also be taken to debt (i.e. Suppliers' credit) in which case the debt portion of funding will be 42%.

In the case of Monorail Projects, the size, number of coaches and other characteristics of the rolling stock decide the moving dimensions and design of civil structures. The signaling and traction power system also have to match with the rolling stock. Similarly the layout and equipments for the Depot as well as the design of turnouts all depend upon rolling stock. We

would therefore suggest that rolling stock, traction system, signaling and telecommunication, depot installation, turn outs, and technology support are all combined into one single package and procured through suppliers' credit and this will cover roughly 60% cost of the project.

Basically there is only 3 suppliers for supply of rolling stock viz.
1 M/s. Hitachi Ltd of Japan.
2. M/s. Bombardier, Germany.
3. M/s. Siemens, Germany.
All these three suppliers are capable of bringing in supplier's credit through their respective EXIM banks or they may be even able to tie up bilateral loans from their respective countries (like JICA, JBIC or KFW) to cover the project supplies. The above funding model will ensure completion of the Project within 3 years and at the minimum cost.

This funding model is therefore recommended for acceptance.

11-Environmental Impact Assessment

Introduction

With rapid economic development, particularly in urban areas, the need for rationalizing and upgrading the transport system is imperative. The travel demand of people has been increasing tremendously. This calls for planning for mass transport system which provides the city with a fast, reliable, convenient, efficient, modern and economical mode of public transport and would reduce vehicular traffic on the roads.

Transport

The city has a reasonably well-developed transport infrastructure. A large number of buses, predominantly run by individual owners, ply on the major routes within the city and to nearby locations. The city has three bus stands.

Regulatory Framework

Environmental Framework: Various environmental standards, specifications and guidelines of Central Pollution Control Board (CPCB) and state level agencies will also be applicable. The Government of India's EIA Notification of 2006 (replacing the EIA Notification of 1994) attracts new/expansion or modernization of any activity falling within the eight specified categories of developmental and industrial activities undertaken in any part of India. Neither railways projects nor urban transport projects are part of specified eight activities. The proposed Two-tier Maglev Magnetic Two-Tier Monorail System project will not attract this notification and therefore environment clearance including conducting of EIA study or carrying out public hearing is not mandatory.

The proposed alignment runs parallel to the seacoast at an aerial distance of about 1.5 km. locations such as crossing may be significant during construction. Since the alignment is away from sea shore it may not require Coastal Regulation Zone (CRZ) Clearance from MoEF.

Social Framework: The Land Acquisition (LA) and Resettlement & Rehabilitation (R&R) of the proposed project would be governed by two Central legislations: (i) Land Acquisition Act, 1894 (amended in 1984), which is an enabling legislation for land acquisition, and (ii) the National Policy on Resettlement and Rehabilitation for Project Affected Families, 2007 (NPRRP). Recently, Govt. Of Puducherry has issued Resettlement and Rehabilitation Guidelines vide.

Alternatives Transport Models Considered In Puducherry City

Mofussil bus stand to puducherry university state entrance for the new transportation system in puducherry city, various alternative modes of alignments were studied have been considered. It was observed that travel on towards Airport corridor is future plan now has been selected for immediate implementation, under and detailed study has been carried out.

Alternate Alignment Analysis

Three alternative alignments were studied to establish the final Two-tier Maglev Magnetic Two-Tier Monorail System covering Rajiv Gandhi Bus Stand Round Turn, Botanical Garden, Rathana Theatre, Raja Signal, Ananda Inn, Ajantha Signal, Baratidhasan College, Muthailpet Kottakuppam, Boomayampalayam, Puducherry university, Kalapet,, Ganapathichettikulam. This alignment makes use of the existing traffic corridor and connects to major traffic hubs of the city. Station locations have been recommended based on existing dispersal facility (existing bus stops) in order to facilitate intermodal transfers and convenience of commuters, and also availability of the required right-of-way for stations. There are 12 stations suggested. The maximum distance is 1.5Km between the stations and the average distance is 0.90 km. Service depot is near puducherry university. Staggered platform arrangements are suggested for station buildings to minimize land acquisition and with specially designed crossovers facility.

Proposed Depot Location

Depot will have the provisions for heavy maintenance, overhaul capability and sub-station will be provided. The depot will cater to store trains, clean them and provide inspection and light maintenance capability. The depot will also house administrative and operational offices as well as facilities for the maintenance of the track, structures and systems along the guideways.

Environmental Baseline Data

The compilation of environmental baseline data is essential to assess the impact on environment due to the project activities. Majority of data on water quality, soil, vegetation, air and noise quality was collected during field studies in April 2015.

Soil Quality

In order to ascertain the quality and nature of soil in the project area, two soil samples were collected, one each at near puducherry university Depot area and near Ajantha Signals. The samples were tested for physical and chemical properties. The sampling sites have been shown in the following figure. The results of soil analysis are presented in

S. No.	Sample /Parameter	Puducherry University	Ajantha Signal
1	pH	6.6	6.9
S. No.	Sample /Parameter	Puducherry University	Ajantha Signal
2	Texture	Sandy loam	Sandy clay
	Sand (%)	12.2	2.4
	Silt (%)	64.4	61.2
	Clay (%)	23.4	35.9 Ajanta signal
3	Nitrogen (meq/100gm)	0.57	0.64
4	Phosphate (meq/100gm)	0.41	0.19
5	K (meq/100gm)	0.60	0.23
6	Ca(meq/100gm)	3.1	5.20
7	Mg (meq/100gm)	1.7	0.84
8	Na (meq/100gm)	2.0	0.62

Water Resources and Quality

Puducherry receives its water supply from surface flow and groundwater. The water is available from surface water source and municipal supplies for domestic use after primary treatment of adding bleaching powder. Although the river is perennial and water is available throughout the year, the supply to the public is not adequate and people have supplemented it by open wells and hand pumps. Four samples have been taken and analysed for essential parameters for drinking water quality.

NP	Sample Code	GW-1	GW-2	SW-1	SW-2	No Relax	
						8.5	
1	Ph	7.77	7.73	7.84	7.72	200	600
2	Alkalinity (mg/l)	124	131	116	104	-	-
3	Phosphate (mg/l)	ND	ND	N.D	1.21	200	400
4	Sulphate (mg/l)	26	26	37	46	45	No Relax
5	Nitrate (mg/l)	11	14	16.42	19	500	2000
6	Total Dissolved solids (mg/l)	963	872	784	869	250	1000
7	Chlorides (mg/l)	67	36	56	42	0.3	1
8	Iron (mg/l)	0.06	0.08	0.41	.26	75	200
9	Calcium (mg/l)					-	-
10	Suspended solids (mg/l)	ND	ND	34	16	1	1.5
11	Fluoride (mg/l)	2.87	2.46	2.26	3.16	-	
12	BOD3 (mg/l)	ND	ND	4	2		

Trees

Tree survey was carried out along the proposed alignment. No forest area exists along the alignment. Most of the trees are along the proposed depot area and some are along either at the centre of the roads or on roadsides at locations of proposed stations. In case where the alignment passes through the green area tree count has been done by quadrate method. The main species are Coconut etc. No rare or endangered species of trees have been noticed during field studies.

Air Quality

As a part of this study ambient air quality monitoring (AAQM) has been carried out by setting up ambient air quality monitoring stations at four locations for six parameters viz. RSPM, CO, HC, SO2, and NOx. The results so obtained are reported in the below table. The ambient air quality data indicates that all the parameters are within the permissible limits established by CPCB at all the monitoring stations.

Location	*RSPM (µg/m³)*	*SO2 (µg/m³)*	*Nox (µg/m³)*	*HC (ppm)*	*CO (µg/m³)*
Near Puducherry Bus Stand					
1st 8 hourly	45	3	5	<0.01	348
2nd 8 hourly	46	3.5	5	<0.01	298
3rd 8 hourly	43.5	3	4.5	<0.01	287

Noise

Noise levels have been measured at five places in Puducherry as per standard practice. The noise levels so obtained are summarized. The locations of Noise level monitoring sites have been shown in the following figure.

Time	Rajiv bus stand	muthailpet	Kootakuppam	Raja signal	Ajantha signal
	N1	N 2	N 3	N 4	N 5
8.00	55.2	55.1	51.1	58.5	52.3
9.00	57.2	56.2	53.8	57.3	55.1
10.00	57.9	59.0	56.0	55.5	56.2
11.00	57.8	58.0	60.0	56.2	59.0
12.00	57.6	58.2	61.7	51.0	58.0
13.00	58.9	58.5	56.3	59.9	56.2
14.00	56.5	57.3	56.6	52.0	51.0
15.00	57.3	55.5	58.5	52.3	59.9
16.00	58.6	56.2	55.6	55.1	52.0
17.00	55.2	51.0	58.0	56.2	58.5
18.00	58.1	59.9	58.5	59.0	57.3
19.00	55.3	52.0	59.0	58.0	55.5
20.00	57.9	52.3	57.6	58.2	58.2
21.00	59.3	58.9	58.3	58.9	58.9
22.00	58.2	57.5	55.9	57.5	57.5
23.00	56.0	55.1	57.2	55.1	55.1
24.00	53.5	55.1	55.9	50.1	50.1
1.00	55.3	52.3	51.3	52.3	52.3
2.00	55.0	53.0	56.7	50.0	50.0
3.00	55.5	55.1	52.3	50.1	50.1
4.00	50.3	59.9	53.5	39.9	39.9
5.00	52.1	55.1	59.3	50.1	50.1
6.00	53.3	57.5	59.9	57.5	57.5
7.00	55.0	55.6	52.8	55.6	55.6

It could be concluded that the noise levels recorded are higher than prescribed permissible levels of 65-dBA (day) at all the locations however in night, noise levels are within the prescribed limit of 55-dBA (night) at all locations.

Socio – Economic Assessment

A socio-economic survey was undertaken for the proposed corridor to assess the socio-economic conditions of project-affected families/people and to examine the impacts of the proposed Two-tier Maglev Magnetic Two-Tier Monorail System alignment on their conditions. On the basis of alignment drawings and field survey work during April and May 2012, it is observed that there are two types of impacts on the PAPs. If there may be displacement of residential/commercial establishments due to acquisition of land etc, employees employed in the working commercial establishments all over the alignment affected due to the acquisition of the shops for the construction and operation of the Two-tier Maglev Magnetic Two-Tier Monorail System will be taken care of. The PAFs/PAPs are dependent on the properties either as land owners or as lessees/ tenants or employees of establishments. These families need to be relocated/ compensated properly.

There is a proposal to widen the road from university to ECR round turn a distance of 10 kms, under the city improvement scheme by acquiring lands to have a right of way of 24 meters for which land has been frozen for about 20 year back. The socio-economic problems arising out of this road widening has not been covered in the above assessment. This will have to be taken care of in the city improvement scheme itself.

Type of Effects

It is evident from the collected data, houses are not going to be affected. However shops are going to function as usual and no effect will be there on their earnings. If in case any shopkeepers are prone to lose their property, will be compensated at Market rates. Moreover, employees are also deriving their subsistence from the affected shops. There will be requirement of providing them alternative job opportunities as per the Resettlement and Rehabilitation guidelines of Government of Puducherry vide notification No. G.O.(Ms) No. 182/ 2012/ RD dated, 03.05.2012. ***Puduvai Trans*** readily provides them with alternative job opportunities, in case they lose their jobs from existing shops.

Negative Environmental Impacts

The main aim of the project is to decongest the road traffic. The project is designed keeping in view population growth, future traffic demands and environmental protection aspects. Attempts have been made to quantitatively predict the impacts due to proposed project. For non-quantitative impacts, qualitative assessment has been made. Potential impacts have been considered, while recommendations for mitigating measures have

Impacts Due To Project Location

Project Affected People (PAPs)

Rehabilitation and Resettlement (R&R) of displaced families is an important issue. The main point to be addressed is the extent to which the “land for land” policy can be maintained for

those who have their own land/house and suitable compensation to those who fall in the category of unauthorized occupants.

Loss of Forests/Trees

The proposed Two-tier Maglev Magnetic Two-Tier Monorail System line is in urban/ city area and will not pass through any forests. Hence no loss to forest is anticipated due to the project. However, planted trees do exist at places in the corridor selected for the project. There are 65 trees along the alignment Trees are major assets in purifications of urban air, which by utilizing CO_2 from atmosphere, release oxygen into the air. However, with removal of these trees, the process for CO_2 conversion will get effected and the losses are reported below:

i)	Total number of Mature Trees	:	71
ii)	Decrease in CO_2 absorption @ 21.8 Kg/ year/ tree for 8 years	:	1508.12 kg
iii)	Oxygen production @ 49 kg/ year tree For 8 years	:	47816 kg

Utility/Drainage Problems

Two-tier Maglev Magnetic Two-Tier Monorail System line is planned to run through the urban area at grade and elevated. The alignment will cross river system, and number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals etc. Since these affect construction and project implementation time schedule/costs for which necessary planning/ action needs to be initiated in advance.

Impact on Archaeological Sites

There is no building of national importance protected by the Archaeological Survey of India along the Two-tier Maglev Magnetic Two-Tier Monorail System route in Puducherry.

Impacts Due To Project Construction

Although environmental hazards related to construction works are mostly of temporary. Appropriate measures should be included in the work plan and budgeted for.
The most likely negative impacts related to the construction works are:

- Soil erosion, pollution and health risk at construction site.
- Traffic diversion and risk of existing building.
- Excavated soil disposal problems.
- Dust Generation.
- Increased water demand.
- Impact due to Construction of Bridge.
- Impact due to Supply of Construction Material.
- Impact due to Construction near Archaeological Structures, and
- Noise Pollution.

Soil Erosion, Pollution and Health Risk at Construction Site

Run off from unprotected excavated areas can result in excessive soil erosion, especially when the erodability of soil is high. Mitigation measures include careful planning, timing of cut and fill operations and re-vegetation. Problems could arise from dumping of construction spoils (Concrete, bricks) waste materials (from contractor camps) etc. causing surface and ground water pollution. However, it is proposed to have mix concrete directly from batching plant for use at site. Batching plants will be located away from the site and from human settlements. The other construction material such as steel, bricks, etc. will be housed in a fenced stored yard. The balance material from these yards will be removed for use/disposal.

Traffic Diversions and Risk to Existing Buildings

During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are on the road but most of the roads are double lane. Hence, wherever possible, rather than completely blocking the roads it will be advisable to make these roads as one way to allow for operation of traffic together with construction activities. Moreover, on both sides of the roads, a clear passage shall be maintained for smooth operation of traffic, emergency and local movements. Advance traffic updates/information on communication systems will be an advantage to users of affected roads. The mono rail corridor does not pose any serious risk to existing buildings.

Problems Of Excavated Soil Disposal

The excavation will be limited to piling activities for foundation for pillars. There will not be major excavation since the corridor involves only elevated section.

Increased Water Demand

The water demand will increase during construction phase. Sufficient water for construction purpose is made available by digging borehole/borewell within the vicinity of the project site during the construction phase. Hence, there will be no negative impact on the residents living in the vicinity of tube wells whose water demand is met by municipal water.

Utility/Drainage Problems

Two-tier Maglev Magnetic Two-Tier Monorail System line is planned to run through the urban area at grade and elevated. The alignment will cross surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, traffic signals etc. Since these affect construction and project implementation time schedule/ costs for which necessary planning/ action needs to be initiated in advance.

Impact due to Construction on Ground Water

Ground water contamination can take place only if chemical substances get leached by Precipitation of water and percolate to the ground water table. This is not the case with the present project, as the activity does not use any harmful ingredients, which could leach down to

water table. Therefore, no impact on ground water quality is anticipated from the project during the construction phase. Proposed project will not alter the existing water.

Impact due to Supply of Construction Material

Two-tier Maglev Magnetic Two-Tier Monorail System construction is a material intensive activity. Different quantity of construction material will be required for construction of the corridor. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is nonetheless, appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources.

Noise Pollution

Construction noise in the community may not pose a health risk or damage to people's hearing, but it can adversely affect people's quality of life. To some degree, construction noise can be a contributing factor to the degradation of someone's health in that it can cause people to be irritated and stressed and can interrupt their ability to sleep - all of which may lead to higher blood pressure, anxiety, and feelings of animosity toward the people or agencies responsible for producing the noise. Construction noise may disturb people at home, in office buildings or retail businesses, in public institutional buildings, at locations of religious services depending upon their vicinity to construction site. Construction noise is unwelcome during night time in residential areas during sleep; it can be equally unwelcome during the daytime in commercial areas if it interferes with people's ability to conduct business. The major sources of noise pollution during construction are movement of vehicles for transportation of construction material to the construction site and the noise generating activity at the construction site itself. The Two-tier Maglev Magnetic Two-Tier Monorail System construction is equipment intensive. A noise prediction is carried out for Lmax and Leq for different combinations of construction equipments working simultaneously at a site. The Result of the noise prediction is presented in

Noise Level Prediction During Construction

Distance in m	Concrete Batch Plant+ Concrete Mixer Truck		Auger Drill Rig +DumpTruck + Generator +Slurry Plant		Dump Truck +Excavator + Pneumatic Tools	
	Lmax	Leq	Lmax	Leq	Lmax	Leq
10	97	91.8	98.3	96.8	99.2	97.6
25	89	83.8	90.4	88.9	91.2	89.6
40	84.9	79.7	86.3	84.8	87.1	85.5
50	83	77.8	84.4	82.9	85.2	83.6
75	79.5	74.3	80.8	79.3	81.7	80.1
100	77	71.8	78.3	76.8	79.2	77.6

Impacts Due To Project Operation

Along with many positive impacts, the project may cause the following negative impacts.

During operation of the project due to the increase in the number of passengers and trains at the stations:

- Noise pollution,
- Water supply and sanitation at Stations,
- Refuse disposal and sanitation, and
- Pedestrian movement and visual issues.

Noise Pollution

During the operation phase the main source of noise could be from running of mono rail cars. Noise radiated from train operations and track structures generally constitute the major noise sources. Airborne noise is radiated from elevated structures. However, as per manufacturers of mono rail cars, noise generated from its operation is not significant.

Water Supply and Sanitation

Public Health facilities such as water supply, sanitation and wash rooms are very much needed at the stations. The water demands will be on station for drinking, toilet, cleaning and also for other purpose like AC, chiller and other purposes. In addition, water will be required for contractor's camps during construction. The water requirement for the stations will be met through the public water supply system after taking necessary approvals. However as an environmental conservation measure, rainwater harvesting will be also carried out at stations.

Station Refuse

The collection and removal of refuse from Maglev Magnetic Two-Tier Monorail System stations in a sanitary manner is of great importance for effective vector control, nuisance abatement, aesthetic improvement and fire protection. The refuse from railway station includes;

- Garbage,
- Rubbish, and
- Floor Sweepings.

Since, Maglev Magnetic Two-Tier Monorail System is a new system in India and there is no past experience in Indian cities, no data is available for station refuse for Maglev Magnetic Two-Tier Monorail System projects in India. Thus, taking data for metro stations in Delhi and other places it can be assumed that the solid waste generation will be about 0.2 – 0.3 cum/day at each stations. Thus about 2.6- 3.9 cum of solid waste will be generated from all the stations. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the operator of Maglev Magnetic Two-Tier Monorail System.

Impacts Due To Depot

One depot is planned for Suspended Monorail at puducherry. This Depot will be near Puducherry University. The area here is barren and with no habitation. In order to develop these areas as depot, it will need filling by earth brought from outside. The depots will have following facilities:

- Washing Lines.
- Operation and Maintenance Lines.
- Workshop, and

- Offices.

Problems anticipated at depot sites are Water supply, Oil Pollution, Cutting of trees, Sanitation, Effluent Pollution, Noise Pollution, Impact due to filling of area and Surface drainage.

Positive Environmental Impacts

Based on project particulars and existing environmental conditions, potential impacts that are likely to result from the proposed development have been identified and wherever possible these have been quantified. This Section deals with the positive impacts of the project. The introduction of the project will also yield benefits from no tangible parameters such as saving due to equivalent reduction in road construction and maintenance, vehicle operating costs, less atmospheric air pollution and socio-economic benefits of travel time, better accessibility, better comfort and quality of life. However, all benefits cannot be evaluated in financial terms due to non-availability of universally accepted norms.

The parameters such as economic growth, improvement in quality of life, reduction in public health problems due to reduction in pollution, etc have not been quantified.

Various positive impacts have been listed under the following headings:

- Employment Opportunities.
- Enhancement of Economy.
- Mobility.
- Safety.
- Traffic Congestion Reduction.
- Reduced Fuel Consumption.
- Reduced Air Pollution.
- Carbon Dioxide and Green House Gases (GHG) Reduction.
- Reduction in Number of Buses, and
- Saving in Road Infrastructure.

Checklist of Impacts

The impact evaluation determines whether a project development alternative is in compliance with existing standards and regulations. It uses acceptable procedures and attempts to develop a numeric value for total environmental impact. A transformation ofthe review of multiple environmental objectives into a single value or a ranking or projects is the final step in impact assessment. There are about hundred methods for carrying out impact assessment, which can be grouped into the following categories:

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
A.	Impacts due to Project Location			
i.	Displacement of People	*		

ii.	Change of Land use and Ecology	*		
iii.	Loss of Cultural and Religious Structures	*		
iv.	Drainage & Utilities Problems	*		
B.	Impact due to Project Design			
i.	Platforms - Inlets and Outlets		*	
ii.	Ventilation and Lighting		*	
iii.	Railway Station Refuse	*		
iv.	Risk due to Earthquakes		*	
C.	Impact due to Project Construction			
i.	Soil Erosion, Pollution and Health risk	*		
ii.	Traffic Diversions and Risk to Existing Buildings	*		
iii.	Problems of Soil Disposal and Seepage Risk	*		
D.	Impact due to Project Operation			
i.	Oil Pollution	*		
ii.	Noise	*		
iii.	Water Demands	*		
iv.	Pedestrian Issues		*	
v.	Visual Impacts		*	
vi.	Employment Opportunities			*
vii.	Enhancement of Economy			*

Network,
_ Overlays,
_ Environmental Index and
_ Cost Benefit analysis.

Each of the methods is subjective in nature and none of these is applicable in every case. Of the 7 methods listed above, checklist has been used and presented. Checklist is a list of environmental parameters or impact indicators which encourages the environmentalist to consider and identify the potential impacts. A typical checklist identifying anticipated environmental impacts is shown in

S. No.	Parameter	Negative Impact	No Impact	Positive Impact
viii.	Mobility			*
ix.	Safety			*
x.	Traffic Congestion Reduction			*

xi.	Less fuel Consumption			*
xii.	Less Air Pollution			*
xiii.	Carbon dioxide Reduction			*
xiv.	Reduction in Buses			*
xv.	Reduction in Infrastructure			*

Environmental Management Plans

The ***Puduvai Trans*** project in Puducherry will provide employment opportunity, quick mobility service and safety, traffic congestion reduction, less fuel consumption and air pollution on one hand and problems of muck disposal, traffic diversion, utility dislocation etc. on the other hand, management of Environment by provision of necessary safeguards in planning of the project itself can lead to reduction of adverse impacts due to a project.
The most reliable way to ensure that the plan will be integrated into the overall project planning and implementation is to establish the plan as a component of the project.

Mitigation Measures

The main aim of mitigation measures is to protect and enhance the existing environment of the project. Hence mitigation measures have been suggested to include:

- Compensatory A forestation.
- Construction Material Management.
- Labour Camp.
- Energy Management.
- Hazardous Waste Management.
- Housekeeping.
- Utility Plan.
- Air Pollution Control Measures.
- Noise Control Measures.
- Vibration Control Measures.
- Traffic Diversion/Management.
- Soil Erosion Control.
- Muck Disposal.
- Water Supply, Sanitation and Solid Waste management.
- Management Plans for Depot, and
- Training and Extension.

12-Recommendations and Way Forward

Puducherry has one of the highest densities in the country. The gross density in the urban areas has increased from 5,553 persons per sq km in 1991 to 7,037 persons per sq km in 2001. The increase in density is mostly due to natural increase and due to migration from nearby villages. The population density in Puducherry municipal limits is 11,303 persons per sq km, which has now reached the saturation level. In future the population is expected to grow more in the outer areas. gives the population density in Puducherry urban area.

Year	Population Projection		
	Arithmetic Method	Incremental Method	Polynomial 2 Order
	Nos		
2001	505,959	505,959	505,959
2006	556,952	568,234	1,769,089
2011	607,945	638,030	2,008,059
2016	658,939	715,347	2,264,382
2021	709,932	800,186	2,538,058
2026	811,918	992,427	3,137,469
2031	842,514	1,055,965	3,330,828

Source: Analysis

Today there is no organized public transport system in the city except a few private busses plying at erratic schedule with the result the city's narrow streets are cluttered with private vehicles particularly 2 wheelers during peak hours. Traffic survey has brought out that the per capita transit trips in the city would be and the total transit trips 63,240 lakhs per year. Therefore a reliable and safe public transport system is essential for the very survival of the city itself and also to accelerate its economic recovery. The public transport system has to be either a bus Rapid transit system, or a light elevated metro or a Monorail system. BRT will need a dedicated bus corridor. This would require widening of the streets to accommodate lanes of traffic in each direction which is impossible in this city due to its heavily built up nature and stiff resistances to land and property acquisition. Therefore a BRT system has to be ruled out. The narrow streets, steep gradients, and very sharp curves also eliminate the possibility of adopting an elevated light metro system. The overhead deck required for such a Metro line would completely block air and light to the streets below. A light Metro has a carrying capacity of 10,000 to 20,000 PHPDT. Such a high capacity public transport system is not sustainable in a city like puducherry. Therefore the only option in the city for a public transport system is the Suspended Monorail which can have sharp curves, steep gradients and which will not block air and light. Suspended Monorail trains with single coaches running at 6 minutes interval is more than enough to cater to the transportation needs of the city till the year.Therefore a Suspended Monorail system, starting from Rajiv Gandhi Bus stand to Puducherry University Entrance State of end for a Length of 17.200 km with 16 stations at an estimated cost of Rs 1148 Crores is

recommended for Puducherry city as Phase I of the project. In the Second Phase, this line can be extended further towards Rajiv Gandhi Bus stand to Ariyuer Sugar Factory a second line, Rajiv Gandhi Bus stand to Manjakuppam and a third line can be considered.

UITPI has the required technical manpower and experience for executing a project of this magnitude. If UITPI is handling the project there is a reasonable possibility of the project getting completed within a period of 3 years

The State Government after approval had taken a decision to engage UITPI as consultants for ***Puduvai Trans*** Two-tier maglev magnetic monorail light rail system project. If UITPI is to handle both the projects together, economy of scale is possible reducing the overall time and costs for both the projects. This will also promote indigenization and vendor development in the country.

UITPI can also hand-hold the UITPI for recruitment and training of O&M staff and over see the operational system for a year or two by which time UITPI should develop confidence and expertise to run the system themselves. It is also recommended, UITPI should introduce feeder services with air-conditioned mini buses from important areas of the city to the Suspended Monorail stations to improve the overall public transport system in the city as also to improve ridership on the Suspended Monorail system. A Over Head Maglev Magnetic Two-tier Monorail Rapid Transit System needs discipline and orderliness on the part of commuters for its smooth functioning. The public have to be constantly educated as to how to use the system and keep the trains and premises clean. This should call for an effective public relation department with UITPI.

The Suspended Monorail system ideally should not depend upon the Government or Municipal Corporation for any subsidy for its operation and maintenance, as also for servicing and paying back the loans taken. For this, it is necessary to ensure that the capital cost is kept to the minimum. State taxes generally accounts for 6 to 8% of the project cost. It is recommended that the State Government gives complete remission of State taxes and duties to this project. Similarly, being a pioneering project in the country and to make Suspended Monorails popular to the medium sized cities, Government of India should also extend duty and tax concessions to this project which will also help to bring down the capital cost further by about 10%. Government of India has given similar concession to Delhi Metro Rail Corporation for the 1st and 2nd phase of the Delhi Metro. A similar treatment and encouragement is necessary for the Suspended Monorail projects in the country, at least in the initial stages.

To make the project financially sustainable it is also necessary to reduce the O&M costs. Cost of energy for running trains and the various systems account for 40% of the O&M cost. The State Government should treat the Suspended Monorail services as a special category and recommend to the electricity regulatory authority a special power tariff to this project on “no loss no profit” basis. Delhi Metro enjoys such a special electricity tariff.

The manpower cost accounts for 25 to 30% of the O&M costs. As strict control on the manpower yard stick is therefore necessary right from the beginning. Further, the work culture, ethics and values of the organization should ensure maximum productivity and excellent customer satisfaction. This has to be ingrained in the organization right from the beginning.

Since the project is being implemented mostly through loans and UITPI will have the responsibility to service and pay back the loans, no fare concession to any section of society is to be allowed till all the loans are paid back. All efforts to augment the fare collections from advertisements, parking fees and commercial exploitation of surplus lands and station spaces should be attempted. If all the above steps are taken the Suspended Monorail System can be made self-supporting.

A significant stream for funding the project is the 20% grant support from the Government of India. The State Government will have to take special interest and steps to obtain this grant from the Ministry of Urban Development, without which the project cannot be made a success.

Dedicated levies for part financing the project and for augmenting the revenue stream. In Puducherry Town there are hardly any Government lands available which can be commercially exploited to raise revenues for part funding of the project. Acquiring private lands at market rates for property development will not be a profitable venture. The city is going to be benefited immensely by having a Suspended Monorail system. It is therefore reasonable to expect the city to contribute towards the capital cost of the Suspended Monorail system as also towards augmenting its revenue streams. We therefore suggest that funds are created through dedicated levies which are solely used for Suspended Monorail system.
Some of the suggestions towards these dedicated levies are –

Way Forward

We would suggest the following actions to take the project forward for its early completion. The State Government should approve the Detailed Project Report and authorize to hand over the project to an organization like UITPI for implementing on a turn-key basis and under deposit terms. The State Government should approach Ministry of Urban Development, Government of India, Ministry of finance, Government of India and Planning Commission for

- To part fund the project with a grant of 20% of the cost.
- To exempt the project from all central taxes and duties for a period of 3 years and To bring the project under the legal cover of Delhi Metro Railway Act. 3) Set up a Special Purpose Vehicle to own and operate this project. Government should also select an outstanding technocrat with impeccable integrity to head the SPV.
- Government should give guarantee for the loans raised for the project.
- Government should set up an empowered Committee of Secretaries under the Chairmanship of the Chief Secretary to monitor the land acquisition work on a fortnightly basis and also for interdepartmental coordination.
- In addition, Government should also set up a group of Ministers to monitor the project and accord all necessary sanctions at Cabinet level.

13-Economic Appraisal

Introduction

Economic appraisal of a project starts from quantification of measurable economic benefits in economic money values, which are basically the savings of resource cost due to introduction of the Maglev Magnetic Two-Tier Monorail. Economic savings are derived from the difference of the cost of the same benefit components under 'with' and 'without' monorail. Total net savings/or benefit is obtained by subtracting the economic cost of the project (incurred for construction (Capital) and maintenance (recurring) costs for the Monorail) from the benefits out of the project in each year. The net benefit value which would be negative during initial years becomes positive as years pass. Internal rate of return and benefit cost ratio are derived from the stream.

The sources from where economic savings occur are identified first. Although there are many kinds of primary, secondary and tertiary benefits, only the quantifiable components can be taken to measure the benefits. These components are quantified by linking with the number of passengers shifted and the passenger km saved by the trips which are shifted from road/rail based modes to metro. It may be observed that first four benefit components given in are direct benefits due to shifting of trips to metro, but other benefit components are due to decongestion effect on the road. Benefit components were first estimated applying market values then were converted into respective Economic values by using separate economic factors which are also given in table. Depending upon methodology of estimation, economic factors are assumed. Overall economic value of benefit components is 88% of the market value. Similarly economic value of the cost components are 80% of the market cost

Cost Benefit Components due to Maglev Magnetic Monorail

Cost/Benefit Components	Economic factors
1 Construction Cost	60%
2 Maintenance Cost	60%
3 Annual Time Cost Saved by Metro Passengers	90%
4 Annual Fuel Cost Saved by Metro Passengers	80%
5 Annual Vehicle Operating Cost Saved saved by Metro Passengers	80%
6 Emission Saving Cost	100%
7 Accident Cost	100%
8 Annual Time Cost Saved by Road Passengers	90%

Values adopted for some important variables

Benefit components are converted (by applying appropriate unit cost) to money values (Rs.). Derivation procedures of some of the values used for economic analysis

	Values	*Important variables*
1	Rs. 1.27/min (2016)	Time Cost derived from passenger's monthly income
2	Market Rate (2012)	Fuel Cost (value of Petrol, Diesel and CNG).
3	Table 15.1	Vehicle Operating Cost (Derived from Life Cycle Cost of different passenger vehicles per km)
4	Table 15.2	Emission (gm/km as per CPCB and UK Norms) Emission Saving Cost (adopted for Indian conditions in Rs/ton).
5	Table 15.3	Accident Rate (No of fatal and all accidents per one Cr.KM). Accident costs are derived from published papers
6	25.33%	Passenger km – Vehicle km conversion factor and mode share percent values (derived from fresh traffic volume count and modal split within study area) .
7	Road User Cost Study Model	Fuel Consumption of vehicles at a given speed is derived
8	Rs. 0.5/vehicle km	Infra Structure Maintenance Cost is derived from published values on annual expenditure on roads and traffic and
9	17.19 min	Average Journey Time Saved after Shifting (Derived)
10	20 kmph	Present Public Transport Journey Speed (Speed & Delay

Table 15.1

Per Vehicle KM	Bus	4 Wh (Large)	4 Wh (Small)	2 Wh (MC)	2 Wh (SC)	3 Wh (Auto)	Mini Bus
Maintenance Cost	3.94	3.31	2.01	0.57	0.72	2.25	2.75
Capital Cost	2.40	2.67	1.20	0.18	0.16	0.72	1.72
Total VOC	6.98	6.58	3.54	0.82	0.96	3.27	4.92

Table 15.2

VEHICLE	CO	HC	NOX	PM	CO	CO2
BUS	3.72	0.16	6.53	0.24	3.72	787.72
2W-2 STROKE	1.4	1.32	0.08	0.05	1.4	24.99
2W-4 STROKE	1.4	0.7	0.3	0.05	1.4	28.58
MINI BUS	2.48	0.83	8.26	0.58	2.48	358.98
4W-SMALL	1.39	0.15	0.12	0.02	1.39	139.51
4W-LARGE	0.58	0.05	0.45	0.05	0.58	156.55
TATA MAGIC	1.24	0.17	0.58	0.17	1.24	160
3W	2.45	0.75	0.12	0.08	2.45	77.89
Cost	RS. 100000 PER TON					500

Vehicle Emission 2011-2021(CPCB) and Cost in Rs.
Accident Rate and Cost i
Table 15.3

Accident Rate in the year 2016	/Cr.Vehicle KM	Cost in Rs

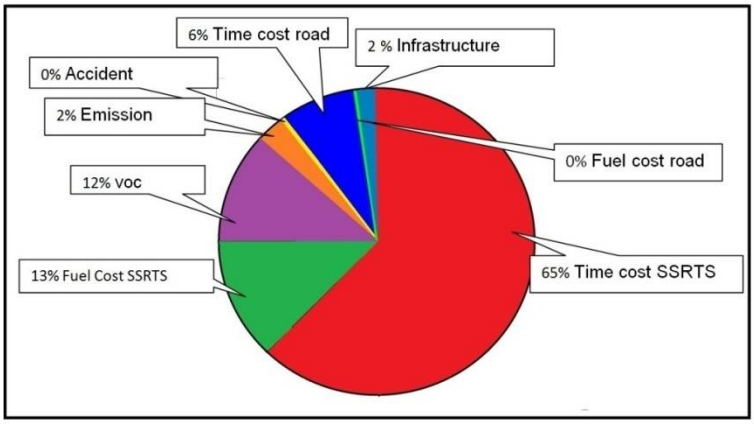
All Types.	1.15	294455
Fatal Accident.	0.08	846324

Traffic parameter values used for economic analysis are given

Particulars	2018	2023	2028	2033	2036	2043
Trips/day Puducherry suspended monorail	124100	136510	156986	180534	207614	238756
Line Length	17.200	17.200	17.200	17.200	17.200	17.200
Average Trip length	6.00	6.00	6.00	6.00	6.00	6.00
Passenger km	744600	819060	941919	1083206	1245687	1432541
Passenger km/km	43290	47619	54762	62977	72423	83287

Economic Benefit Stream

Benefits in terms of money value are estimated directly from the projected passenger km saved for the horizon years (2016, 2021, 2026, 2031 and 2041) and values for other years are interpolated on the basis of projected traffic. Market values are used for calculating costs and then appropriate economic factors are applied. For each year values of each benefit components are obtained and thus benefit stream is estimated. Benefit Components Stream for ***Puduvai Trans*** Monorail Project Benefit components for the year 2019 are shown in figure below, which shows benefits are mainly coming from saving of travel time (65%), VOC (12%) and fuel cost (approximately 13%). Other benefits are marginal. In this area, personalized modes (car and two wheelers) are dominant which have made vehicle by passenger ratio very high (25%). Average modal split obtained from the traffic volume count survey shows that 79.35% vehicle trips are by private modes as may be seen in. Obviously presence of dependable mass transport system is not there.



Percent of Benefits

Two-tier Maglev-Monorail Construction Cost

Total cost of project construction (CAPITAL COST) is derived after considering cost of all major component such as Relocation and Rehabilitation(RR), Civil construction for underground and elevated portions, Stations and Depots, Track laying, Signaling and telecommunication, Power traction line, Rolling stock, Man power etc. RUCURRING COST includes energy cost, maintenance cost, and operation cost. Economic analysis period is taken from 2015-16 to 2041-42 out of which 5 years are marked as construction period. Additional capital intensive costs may occur in the years 2022-23, 2031-32 and 2038-39. Operation is expected to be started in 2018- 2019.

Economic Performance Indicators

After generating the cost and benefit stream table, values of economic indicators are derived and are presented in **table below**. Project period is 15 years i.e. 2018-2033, ROI (without tax) is found to be **42.17%** and Gross Return ratio as 20.13 shows that the project is economically viable.

Puduvai Trans Rapid System	*Without Discount (Rs. In Cr.)*
Total cumulative cost	1148
Total cumulative benefit	1559
NPV	411
ROI	35.80%

Average modal split in study area

Year	Year	Annual Time Cost Saved by Puduvai trans Passengers in Cr. Rs.	Annual Fuel Cost Saved by Puduvai trans Passengers in	Annual Vehicle Operating Cost Saved by Puduvai trans Passeng	Emission Saving Cost in Cr.Rs.	Accident Cost in Cr.Rs.	Annual Time Cost Saved byRoad Passengers in Cr. Rs.	Annual Fuel Cos Saved by Road Passengers in Cr. Rs.	Annual Infra Structure Maintenance Cost in Cr. Rs.	Total Benefits without Discount in Cr.Rs.
2018	2019	142.90	27.06	23.64	5.40	0.97	13.89	0.62	4.10	218.57
2019	2020	158.00	28.36	26.21	4.96	1.07	15.12	0.66	4.29	238.68
2020	2021	174.71	29.72	29.06	5.50	1.19	16.47	0.71	4.48	261.85
2021	2022	191.74	31.05	32.10	6.08	1.31	17.87	0.75	4.68	285.58
2022	2023	210.43	32.44	35.45	6.71	1.45	19.39	0.80	4.87	311.55
2023	2024	230.95	33.90	39.16	7.42	1.60	21.03	0.85	5.08	339.99
2024	2025	253.47	35.44	43.25	8.19	1.77	22.82	0.90	5.30	371.13
2025	2026	278.18	37.05	47.77	9.05	1.96	24.76	0.96	5.52	405.23
2026	2027	302.65	38.57	52.53	9.95	2.15	26.74	1.01	5.73	439.34
2027	2028	329.28	40.16	57.77	10.94	2.36	28.89	1.07	5.95	476.42

2028	2029	358.25	43.82	66.55	12.60	2.60	33.38	1.18	6.47	524.86
2029	2030	389.77	45.64	73.19	13.86	2.86	36.06	1.24	6.72	569.34
2030	2031	424.06	47.55	80.49	15.24	3.14	38.95	1.31	6.97	617.72
2031	2032	465.22	49.83	89.16	16.53	3.47	42.44	1.40	7.29	675.35
2032	2033	510.38	52.23	98.77	17.92	3.83	46.25	1.49	7.63	738.50
2033	2034	559.92	54.74	109.41	19.44	4.23	50.40	1.59	7.97	807.71
2034	2035	614.27	57.37	121.21	21.08	4.68	54.92	1.69	8.34	883.55
2035	2036	673.90	60.12	134.27	22.86	5.16	59.85	1.81	8.72	966.68
2036	2037	739.31	63.01	148.74	24.79	5.70	65.22	1.93	9.12	1057.81
2037	2038	811.07	66.04	164.77	26.88	6.30	71.07	2.05	9.53	1157.71
2038	2039	889.80	69.22	182.53	29.15	6.95	77.44	2.19	9.97	1267.24
2039	2040	976.17	72.54	202.20	31.61	7.68	84.39	2.33	10.42	1387.34
2040	2041	1070.92	76.03	223.99	34.27	8.48	91.96	2.49	10.90	1519.04
2041	2042	1174.87	79.68	248.13	37.17	9.36	100.21	2.65	11.40	1663.47

Estimated Capital and Recurring Cost including Central Tax

Passenger Vehicles	% Pass	% Veh
Bus	49.56%	4.35%
Tempo	4.96%	1.09%
Car	12.33%	17.39%
Taxi	3.30%	3.26%
2 Wh	21.97%	61.96%
Auto	7.87%	11.96%
	100.00%	100.00%

Estimated Capital and Recurring Cost Including Central Tax

Year	Cash Flows	Expenses	Net Profit	Interest @ 1.40%	Net Profit Post Interest	Balance to be repaid
1	3,82,76,24,221					
2	3,82,76,24,221					
3	3,82,76,24,221					
	11,48,28,72,664					
4	35,67,60,000	6,42,60,000	29,25,00,000	16,07,60,217	13,17,39,783	(11,35,11,32,881)
6	47,18,15,100	7,08,46,650	40,09,68,450	15,63,41,468	24,46,26,982	(10,92,26,20,760)
7	54,25,87,365	7,43,88,983	46,81,98,383	15,29,16,691	31,52,81,692	(10,60,73,39,068)
8	62,39,75,470	7,81,08,432	54,58,67,038	14,85,02,747	39,73,64,291	(10,20,99,74,777)
9	71,75,71,790	8,20,13,853	63,55,57,937	14,29,39,647	49,26,18,290	(9,71,73,56,486)
10	82,52,07,559	8,61,14,546	73,90,93,013	13,60,42,991	60,30,50,022	(9,11,43,06,464)
11	94,89,88,693	9,04,20,273	85,85,68,419	12,76,00,291	73,09,68,129	(8,38,33,38,335)
12	1,09,13,36,996	9,49,41,287	99,63,95,710	11,73,66,737	87,90,28,973	(7,50,43,09,363)
13	1,25,50,37,546	9,96,88,351	1,15,53,49,195	10,50,60,331	1,05,02,88,864	(6,45,40,20,499)
14	1,44,32,93,178	10,46,72,769	1,33,86,20,409	9,03,56,287	1,24,82,64,122	(5,20,57,56,377)
15	1,65,97,87,154	10,99,06,407	1,54,98,80,747	7,28,80,589	1,47,70,00,158	(3,72,87,56,219)
16	1,90,87,55,228	11,54,01,728	1,79,33,53,500	5,22,02,587	1,74,11,50,913	(1,98,76,05,306)
17	2,19,50,68,512	12,11,71,814	2,07,38,96,698	2,78,26,474	2,04,60,70,224	5,84,64,918
18	2,52,43,28,789	12,72,30,405	2,39,70,98,384	-	2,39,70,98,384	2,45,55,63,302

Year	*Cash Flows*	*Expenses*	*Net Profit*	*Interest @ 1.70%*	*Net Profit Post Interest*	*Balance To Be Repaid*
1	3,82,76,24,221					
2	3,82,76,24,221					
3	3,82,76,24,221					
	11,48,28,72,664					
4	35,67,60,000	6,42,60,000	29,25,00,000	19,52,08,835	9,72,91,165	(11,38,55,81,499)
5	41,02,74,000	6,74,73,000	34,28,01,000	19,35,54,885	14,92,46,115	(11,23,63,35,384)
6	47,18,15,100	7,08,46,650	40,09,68,450	19,10,17,702	20,99,50,748	(11,02,63,84,636)
7	54,25,87,365	7,43,88,983	46,81,98,383	18,74,48,539	28,07,49,844	(10,74,56,34,792)
8	62,39,75,470	7,81,08,432	54,58,67,038	18,26,75,791	36,31,91,247	(10,38,24,43,546)
9	71,75,71,790	8,20,13,853	63,55,57,937	17,65,01,540	45,90,56,397	(9,92,33,87,149)
10	82,52,07,559	8,61,14,546	73,90,93,013	16,86,97,582	57,03,95,431	(9,35,29,91,717)
11	94,89,88,693	9,04,20,273	85,85,68,419	15,90,00,859	69,95,67,560	(8,65,34,24,157)
12	1,09,13,36,996	9,49,41,287	99,63,95,710	14,71,08,211	84,92,87,499	(7,80,41,36,658)
13	1,25,50,37,546	9,96,88,351	1,15,53,49,195	13,26,70,323	1,02,26,78,872	(6,78,14,57,787)
14	1,44,32,93,178	10,46,72,769	1,33,86,20,409	11,52,84,782	1,22,33,35,627	(5,55,81,22,160)
15	1,65,97,87,154	10,99,06,407	1,54,98,80,747	9,44,88,077	1,45,53,92,671	(4,10,27,29,489)
16	1,90,87,55,228	11,54,01,728	1,79,33,53,500	6,97,46,401	1,72,36,07,099	(2,37,91,22,391)
17	2,19,50,68,512	12,11,71,814	2,07,38,96,698	4,04,45,081	2,03,34,51,617	(34,56,70,773)
18	2,52,43,28,789	12,72,30,405	2,39,70,98,384	-	2,39,12,21,981	2,04,55,51,207

The ***Puduvai Trans*** Maglev Magnetic Two-tier Monorail Project, covers 17.200 kms with 16 stations and will have a completion cost of Rs1148 crores. Monorail Projects are generally not financially viable. Puducherry city does not have vacant Government or Corporation lands which can be offered for commercial exploitation to augment revenues of the Monorail system. Therefore implementing this project on a BOT basis is possible whereas a PPP model is not possible. It is therefore recommended that the project is implemented fully as a Government support initiative. By this route, the project can be completed at the shortest time and at the lowest possible cost. This is important, because then only tickets can be priced low, affordable to the common citizens and make the system truly a popular public transport. If the Government is to execute the project departmentally through existing Government departments like PWD, it would take several years with prospects of huge cost escalations. Infrastructures projects of this magnitude and complex cannot be executed by Government departments following Governmental rules, guidelines and procedures. It is therefore recommended that a Special Purpose Vehicle (SPV) with wide powers and mandates, is set up to execute the project in time and within the estimated cost. A Company under the name "Unity Infra Transit Project Implementers "(UITPI) or any other appropriate name should be set up and given full responsibility for implementing the project. It is therefore imperative; the SPV is headed by a mature and experienced technocrat with excellent track record and impeccable integrity. The whole success of the venture depends upon the leader chosen to head the SPV. Although UITPI will be the owner or client, the actual execution of the project will be done on a turn-key basis and on deposit term by an empowered agency as explained under. Therefore, the SPV should be a very LEAN BUT EFFECTIVE organization mainly functioning as a single window for Land acquisition, getting clearances from various agencies, mobilizing and releasing funds to the executing agency as and when required, monitor the

progress and, in short, act as the owner of the project. The total number of staff of the SPV should not exceed 6 or 8 during construction phase mainly to reduce cost to the project

Implementation Strategy

The ***Puduvai Trans*** Monorail has to be implemented through very narrow and congested streets. Barring the sole example of Mumbai monorail, the country has no precedence, experience and expertise in planning, designing and executing monorail projects.

Puducherry Government or the SPV (UITPI) has two options to execute the project By engaging international IAT-MAGLEV for design, drawing up specifications, preparation of tender documents, finalization of contracts and project management will cost about 4 to 5% of the project cost. If IAT-MAGLEV is engaged, still the SPV (Special Purpose Vehicle) will require a huge organization to oversee IAT-MAGLEV work. The establishment cost of the SPV will also be about 4 to 6% of the project cost. Thus 8 to 11% of the project cost will be spent on General Charges alone. Worse still, the SPV will not be able to build up its technical team, since such competent and experienced persons with Railway background are not just available in the country To reduce the cost and get the project implemented in the shortest time, we would recommend the second option viz. Handing over the project on a turn-key basis and on deposit terms to an organization, which has the capacity, resources and technical competence to handle a complex project of this type.

Implementation sequence

Rolling stock is the back-bone of a Two-tier Maglev-Monorail System. Rolling stock determines, the moving dimensions, load, longitudinal and lateral forces, length of trains and therefore platform lengths. The signaling, telecommunication, and traction systems, size of the concrete & tracks magnetic tracks suspended mono rail, turnouts, depot layout and planning, all depend upon and must integrate well within the rolling stock. There are basically only three manufacturers of rolling stock and each have their own distinct designs and characteristics not only in regard to Coach Dimensions but also with regard to associated sub systems mentioned above. Any change from their existing designs will cost a lot more. We would therefore recommend, without laying down exact dimensions and specifications, Rolling stock and connected sub systems like signaling & telecommunication, traction, depot equipments, turnouts etc are all combined into one single contract package and the rolling stock supplier selected first. The rolling stock supplier will also be the technology partner and will have the responsibility for technology integration and make the total system safe and reliable. This is the first contract, therefore to be finalized. This process will take about 8 months. Meanwhile, Land acquisition work can be progressed and most of the lands taken over.

Civil Contractor for viaduct and stations can be finalized and foundation and substructure work can also be progressed but fine-tuning of the track-beams can be done only after technology partner is in position. Contracts for Power supply, power distribution, automatic fare collection, architectural works etc can also be finalized in the meantime. By the time the first train set is received, minimum facilities at the car depot have to be ready.

The stretch from new Rajiv Gandhi Bus stand to Puducherry University via end of the state entrance, is very narrow and the road does not have sufficient width to accommodate Maglev Magnetic Two-tier Suspended Monorail pillars along the centre. State Government has taken a decision to widen this road by acquiring land which is already frozen by the City Planning Department. Acquisition of land for this widening will take considerable time as a large number of people have to be rehabilitated. This will therefore be a most critical length for completion of civil works. A plan of action, backed by a detailed project report, for completing the civil works on this stretch within a time frame of 36 months has to be finalized before the Monorail project is taken up.

Implementation period

Based on the approach indicated in above, requirements of rolling stock, signaling, telecommunication, traction, car depot and turn outs should all be clubbed into a single contract package and invite global tenders should be invited. Bringing in funds either through suppliers' credit or through bilateral loans will also be a part of this tender package. The successful tenderer will be selected based on technological superiority and based on the most competitive financing arrangements. An appropriate weight age formula for these two items i.e., technological superiority and best financing terms on NPV basis, all in a very transparent and easy understandable basis should be worked out. The successful bidder then becomes the technological partner and will have the responsibility to integrate all systems. It is expected, the technological partner can be identified and selected within a period of 8 months. The schedule for completion of the project will then be as under Legal and Institutional Cover for **UITPI**

Monorail is a new system of guided urban transport from Indian perspective and it is important that the issues related to its Legal and Institutional cover are addressed at the initial stage of project conceptualization. There is no mono-rail system operational yet in the country and one system which is in advanced stage of construction at Mumbai is being developed under Tramways Act, which we feel is not technically correct as a Suspended Maglev-Monorail is no way akin to a Tramway. Developing a robust legal and institutional cover for Mono Rail is important from the key perspective because many medium and million plus cities of the country will be adopting this system particularly in the corridors where Metro Rail is not justified or technically not feasible.

The subject of appropriate Legal and Institutional cover for Mono Rail at Puducherry has been examined and we are of the following opinion:- Suspended Two-tier Maglev-Magnetic Monorail cannot be brought under the category of Railways or Tramway. Therefore, neither the Indian Railway Act 1998 nor Tramway Act is applicable for a Suspended Monorail. However, this is a rail-guided system mentioned in Clause 2((1) (i) of the Delhi Metro Railway (operations & Maintenance) Act, 2002.

We therefore recommend that

- Construction of Mono Rail should be done under The Metro Rail (Construction) Act, 1978.
- Operations and Maintenance of Mono Rail should be done under The Delhi

Metro Railway (Operations and Maintenance) Act, 2002.

However to ensure that the above Legal and Institutional cover are applied in a practical and correct manner following changes will be required to be made in the above Acts: a. In the definition of Metro-railway under Clause 2(1) (i) of the O&M Act as amended in 2009, the word "rail guided" should be replaced by "guided". Such a change is necessary on account of the fact that Mono-Rail, though guidway in nature, runs on steel guidway rail.

In the definition Central Government 2(1) (a) which specifies that in relationship to Technical Planning and Safety of Railways it will mean Ministry of the Government of India which deals with Railways, certain changes are needed. The changes are required owing to the fact that Mono Rail is a new system about which Railway Ministry does not have necessary knowledge or expertise. Therefore till the country builds a few Monorails and operates them we have to depend on International reputed technical expertise for laying down technical parameters and also for safety certification. Therefore overall technical planning and safety shall vest with Indian Railways it should discharge its responsibility only based on recommendations of International reputed technical expertise of Monorail.

Similarly the safety shall be the direct responsibility of Commissioner Metro Rail Safety (and not Ministry of Railways). The necessary changes in O&M Act will be required to reflect that Chief Commissioner of Rail Safety shall discharge his functions independently and on discharging such functions it shall depend on the expert advice of the Reputed International Mono Rail Safety and Technical Experts The above changes with regard to safety responsibility shall be made in definition 2(1) (a) of O&M Act as well as Chapter IV Commissioner of Railway Safety (a new Sub-clause (e) to this effect in Clause 8 and in Chapter V Opening of Metro Railway (a new sub-clause in Clause 15 or a new clause al-together for Mono Rail).
To sum up, this is yet early days for development of innovative urban transport solution of Mono Rail in the country. It is an absolute must that the cities of the country have best technical advice and safety solutions available at par with best international practices and as such it is considered essential that both technical planning as well as safety receives the expertise of best International Technical and Safety Experts having robust knowledge of Mono Rail Systems. As such while the legal and institutional for development and O&M of Mono Rail shall be as described above, the same shall be in consonance with the necessary suggested amendments in the above Acts.

Operation & Maintenance

If the ***Puduvai Trans*** Two-tier Maglev monorail & Suspended Monorail Project is to be a success it is essential to ensure that the capital cost is kept to the minimum, the operation & maintenance costs are also kept to the minimum and non-operational revenues are increased to the maximum. The operation and maintenance can be handled either directly by the SPV or out sourced. There are no Indian agencies who are experienced in operating and maintaining a Mono rail system. Therefore if the operation and maintenance is outsourced foreign companies will have to be involved which will considerably increase the operation and maintenance costs.

We would therefore recommend that the SPV directly takes over the full responsibility for operation & maintenance of the system.

Operation & Maintenance

If the operation & maintenance of the system is undertaken by the SPV, the total manpower requirement will be approximately 350 at the rate of 25 persons for route kilometer. In addition, the cleaning of stations and cleaning of train sets have to be outsourced. The O & M set up and organizational strength for each activity can be finalized in due course after the technology partner is in position.

Security

A Public transit system, particularly rail based or guided, running on elevated structures is highly vulnerable to sabotage or other terrorists activities. The ***Puduvai Trans*** Monorail System should therefore have a fool-proof security system to ensure the safety of passengers and safety of the installations. The security of the Delhi Metro System is handed over to the Central Industrial Security Forces (CI*SF).* The State Police is responsible for the security of the Bangalore Metro system. To enable the State Government to have full control on the security of ***Puduvai Trans*** Rapid System, we would recommend that security is handed over to the State Police which should deploy sufficient personnel at stations and vital installations. The strength and set up of such security system should be worked out by the State Government in due course.

Conclusion

Rapid increase in traffic volume in transport systems plus the need for improving passenger comfort have highlighted the subject of developing new transport systems. The recent required increases in the traffic volume in transport systems, as well as a need for the improvement of passengers' comfort, and required reductions in track life cycle costs, have caused the subject of the development of a new transportation system. One of the important systems which have attracted industries is Maglev Magnetic Two-tier Monorail transport system. In this regard, Maglev Magnetic Two-tier Monorail transport system turns out to be a proper choice for transportation industries around the world. Maglev Magnetic Two-tier Monorail systems have been recently developed in response to the need for rapid transit systems. The Maglev Magnetic Two-tier Monorail system comes off clearly better and surpasses the conventional railway systems in almost most fields. These include the pollution, noise emission, vibration level, environmental issues, land occupations, loading, speed, acceleration and deceleration, braking, maintenance costs, passenger comfort, safety, travel time, etc. With the Maglev Magnetic Two-tier Monorail guideway it is also possible to reach to the minimal radiuses for the horizontal and vertical curves. A Maglev Magnetic Two-tier Monorail vehicle can as well travel at the steeper gradients compared with the conventional rail systems.

14- why in puducherry? Why not anywhere else.

This is the birth place of the founder, director Mr. Dhoulath sah. So, he is first interested to do something fruitful for the people of puducherry.
Investors are happy funding in puducherry because of its aesthetical, foreign ancestral views.

The Unity Infra Transit Project Implementers are happy and readily welcome such projects to be executed not only in puducherry but in other parts of the country too.

15-Puducherry Reports

The total area of the union territory is 479 square kilometers and it comprises four small unconnected districts - Puducherry, Karaikal, Yanam and Mahe. Mahe lies in the Arabian Sea while the other three districts lie in the Bay of Bengal. The largest sections are Puducherry and Karaikal which are enclaves of Tamil Nadu. Mahe and Yanam are enclaves of Kerala and Andhra Pradesh respectively. Puducherry district comprise an area of 293 square kilometers, Karaikal160 square kilometer, Yanam 30 square kilometers and Mahe 9 square kilometers. Puducherry district is situated about 180 km south of Chennai on the east coast of India. Karaikal lies about 150 km from Puducherry on the east coast. Yanam also lies on the east coast near Andhra
Pradesh. Mahe is situated on the Western Ghats near Kerala.

Transport in Puducherry

Being an internationally renowned place for its French legacy, Puducherry provides a great network of roads in all parts of the union territory. There are national highways that run here and join it to other parts of the country. Buses, private vehicles can be found here which are very convenient. There are regular buses that ply from Chennai every half hour. There is also an airport in the Puducherry town. However it is a domestic airport. International airport can be found in Chennai.

Tourism

The place is a true delight for every visitor. Auroville is the most popular destination in Puducherry. The French Quarter, the food, the tradition and the French colony are the attractions here. You can find world class beaches here. So, if you love the sun and the water, you can enjoy here to your hearts content.

The beaches are quite and beautiful. Trees are lined up at the beaches. Besides, there are various monuments that you can see, like the churches, the colonial buildings, temples built during the ancient times, botanical gardens, museums and many more. The attraction here for foreign and Indian tourists is the Aurobindo Ashram built in 1926. It is an educational center and holds a place of respect as well

Pondicherry University is a central university in Puducherry, India. Founded in 1985 by the Government of India, the university is a collegiate university with a jurisdiction spread over the Union Territories of Puducherry, Lakshadweep and Andaman and Nicobar Islands. It has 35000 students in its 87 affiliated collegesincluding 27,000 students in the distance education mode. The current strength of students studying on-campus stands at 6500. It has introduced innovations like the Choice-based Credit System and on-line admission for postgraduate studies. Pondicherry University is ranked as one of the top ten Universities in India based on the survey conducted on 2013.

Location

Pondicherry University is located in a campus spread over 780 acres (3.2 km2), facing the Bay of Bengal on the East Coast Road. It is accessible from Chennai (168 km) and Bangalore.

List of affiliated colleges

- Achariya Arts and Science College
- Arignar Anna Government Arts College
- Avvaiyar Government College for Women
- Bharathidasan Government College for Women
- Bharathiar Palkalaikoodam
- Christ College Of Engineering and Technology
- Dr. S.R.K. Government Arts College
- Fostiima Business School
- Bangalore Management Academy
- Idhaya College of Arts and Science for Women
- Indira Gandhi College of Arts and Science
- Jawaharlal Nehru Rajkeeya Mahavidyalaya
- Kanchi Mamunivar Centre for Post Graduate Studies
- Mahatma Gandhi Government Arts College
- Mahatma Gandhi Government College
- Perunthalaivar Kamarajar Government Arts College
- Rathnavel Subramaniam College of Arts and Science
- Saradha Gangadharan College
- Tagore Arts College
- Tagore Arts College(Annexe)
- United College of Arts and Science
- Villianur College for Women
- Dr.Ambedkar Government Law College
- R.V.S College of Engineering and Technology
- Perunthalaivar Kamarajar Institute of Engineering and Technology
- Bharathiar College of Engineering and Technology
- Pondicherry Engineering College
- Rajiv Gandhi College of Engineering and Technology
- Regency Institute of Technology
- Sri Venkateshwaraa Medical College Hospital and Research Centre
- College of Nursing
- Kasturba Gandhi College of Nursing
- Mahatma Gandhi Dental College and Hospital
- Mahatma Gandhi Medical College & Research Institute
- Mother Teresa Institute of Health Sciences
- Pondicherry Institute of Medical Sciences

- Rajiv Gandhi College of Veterinary Animal Sciences
- Regional Medical Research Institute
- Vector Control Research Centre (ICMR)
- Achariya College of Education
- Alpha College of Education
- Arutperunchothi Ramalingasamy College of Education
- Co-operative College of Education
- Don Bosco College of Education and Research Institute
- Dr. Anbu Paul College of Education
- Immaculate College of Education
- Krishnasamy College of Education for Women
- Loyola Institute of Teacher Education
- Mahe Co-operative College of Education
- Mother Teresa BEd College
- Nehru College of Education
- Perunthalaivar Kamarajar College of Education
- Pope John Paul II College of Education
- Regency College of Education
- Senthil College of Education
- Sree Narayana College of Education
- Tagore Government College of Education
- Vasavi College of Education
- Venkateswara College of Education
- Vivekanandha College of Education
- Shri Krishnaa College Of Engineering and Technology, Mannadipet, Puducherry
- Sri Manakula Vinayagar Engineering College
- Sri Manakula Vinayagar Medical College and Hospital
- Manakula Vinayagar Institute of Technology
- Sri Manakula Vinayagar Nursing College
- Usha Latchumanan College of Education
- Venkateswara Teacher Training Institute
- Acharya College of Engineering & Technology
- Alpha College of Engineering
- Sri Ganesh College of Engineering and Technology
- Dr. S.J.S. Paul Memorial College of Engineering & Technology
- Indira Gandhi Medical College
- Sree Lakshmi Narayana Institute of Medical Sciences

Sunday Market

Every Sunday, hole day all puducherry people comes in this place "***Sunday Market*** " 2 laces people vesting this market the long stretch of Mahatma Gandhi Road turns into a shopping

ground not only for Puducherrians but also for tourists. Offering a wide range of products, the Sunday market has grown into a popular site over the years, attracting huge crowds every Sunday.Starting with varieties of textile items, fashion jewellery to footwear, electronic items, old books and house utilities, the roadside outlets of the Sunday market sell a plethora of products at affordable costs.

“The market draws a lot of people including tourists and foreigners. People get what they need here and that too at an affordable price. The crowd is huge every week,”,who has been selling bed covers, curtains and pillow covers for the last seven years here. According to shopkeepers, the concept of Sunday market came in over 30 years ago. From different kinds of bags, plastic items, watches, garments, caps, electronic goods, the line of shops on M.G. Road seem to sell everything under the sky now. Of all, it consists of numerous shops selling clothes for children. Shopkeepers pointed out that the market continues to attract people over the years and persons from different strata of the society shop here. This was indeed a unique feature of the market,

“While one stretch of M.G. Road primarily sells textile goods, the other side consists of toys for children, electronic goods and books With over 2,000 shops, the Sunday market has grown into a popular one-stop shopping place for Puducherrians. “We have regular customers from Chennai too. Sellers from Tindivanam, Chennai, Villupuram and Puducherry put up their shops here. On Sundays, the regular shops on M.G. Road close their outlets,” he added.

See

Gandhi Statue on Beach Road Pondicherry has managed to retain its french flavour. Charles de Gaulle style cap. Pondicherry,India

- The Beach
- Barathi Park
- Churches
- Chunnambar Boat House(which is crowded on holidays and weekends)
- Mahatma Gandhi's statue, Beach Rd. edit
- Oustery Lake(Only as a view but not developed)
- Paradise Beach
- Sri Aurobindo Ashram
- Government Museum
- Auroville city
- Boat House
- Manakula Vinayagar Temple
- Villianur - St. Lourd Church (7km from Pondicherry towards Villupuram)
- Villianur Thirukameeswarar Temple
- Auro Beach (Opposite to Auroville City)
- Botanical Gardens (Entrance east). A nice park, though a little in disarray. Entry free.

Tiruvannamalai

Known as fifth Hindu element of fire, it is located around 107 km from Pondicherry and ranks as one of the pilgrim city in Tamil Nadu. Its name meaning 'Red Mountain' came from the extinct of Volcano, Arunachala.

Kancheepuram

It is named as 'The City of Thousand Temples' and belongs to 23rd century. Today, the town is mainly known for its quality silks. Mahabalipuram - Nestled along the Bay of Bengal, it was seventh century port of Pallava kings. Several cave temples are carved here from Granite hill which belongs to fifth and eighth centuries.

Institutions

- Dr. Ambedkar Govt. Law College, Periakalapet, Puducherry
- Mahatma Gandhi Medical College & Research Institute, Pillaiyarkuppam
- Pondicherry University, Kalapet
- Indira Gandhi Medical College & Research Institute (Govt. of Puducherry)
- Pondicherry Science Forum
- Pondicherry Institute of Medical Sciences, Kalapet
- Indira Gandhi College of Arts and Science
- College of Nursing, Pondicherry Institute of Medical Sciences, Kalapet
- Shri Krishnaa College of Engineering & Technology, Mannadipet, Thirukkanur
- RAAK Nursing College, Arumbharthapuram
- Tagore Arts College, Lawspet
- Kanchi Mamunivar Centre for Post-Graduate Studies, Lawspet
- Mahatma Gandhi post graduate institute for dental sciences
- Manakula Vinayagar Institute of Technology
- Jawaharlal Institute of Postgraduate Medical Education & Research
- Bharathidasan Government College for Women
- Mother Theresa Post-Graduate and Research Institute of Health Sciences
- Alpha College of Engineering & Technology
- Rajiv Gandhi Institute of Veterinary Education and Research
- Sri Ganesh College of Engineering & Technology
- Sri Manakula Vinayagar Engineering College
- Rajiv Gandhi College of Engineering and Technology
- Pondicherry Engineering College
- Perunthalaivar Kamarajar Institute of Engineering and Technology
- Achariya Arts & Science College
- Christ College of Engineering & Technology
- Saradha Gangadharan Arts & Science College
- Achariya College of Engineering & Technology
- Raak Engineering College, Arumbharthapuram
- Barathidasan Government College for Women
- Fatima Higher Secondary School

- Perunthalaivar Kamarajar Government Boys' High School
- Rajah Higher Secondary School
- Sinnatha Government Girls' Higher Secondary School
- Sri Aravindar Higher Secondary School
- St. Joseph's Girls High School
- New Modern Vidhya Mandhir School
- vasavi international school

Muthialpet

Main Street

- Perumal Naidu Street
- St. Rozario Street
- Muthiyamudaliar Street
- Ponnambala Mudali Street
- Barathidassan Street
- Salai Street
- Belkis Street
- Perumalpet Street
- solai nagar street
- saukupet streety
- Sebesthiar church St 2cross dutert

Division

- Angalamman Nagar
- Chinnayapuram
- Danusupillai Thottam
- Debasanpet
- Ganapathy Nagar
- Ganesh Nagar
- Kattamanikuppam
- Lourdhu Nagar
- Manjini Nagar
- Perumalpet
- Pudupalayampet
- Ramakrishna Nagar
- Ramalinga Nagar
- Senthamari Nagar
- Shevarayapet
- Solai Nagar
- Sooriyagandhi Nagar
- St. Simonpet

- T.V. Nagar
- Vaazhaikulam
- Vasantham Nagar
- V.O.C Nagar

Churches

- Holy Rosary Church, Muthialpet
- St Antony Church, Muthialpet
- Sebesthiar church muthialpet

Temples

- Sri Periyapaalayathamman Aalayam, Perumalpettai Street.
- Sri Sundara Vinayakar Subramanya Swamy Siddhivinayaka Temple
- Lakshmi Hayagriva Temple
- Ezhai-Mariamman Koil
- Sri Thenkali Srinivasa Perumal Koil
- Senkazhuneer Amman Temple
- Vardha Valli Mariamman Koil - Near Yanai Moonji Maram
- Muthumariamman Muthayasamy Koil
- Manmadhan Or Kaaman Koil
- Ponnumariamman Koil
- Muthuratchaga Mariamman Koil
- Sri Thenkali Srinivasa Perumal Koil 200 Years Geared Sapparam - Sri
- Thenkalai Srinivasa Perumal Koil

Important Place

- Clock Tower
- Muthialpet Clock Tower
- Market A 100-year-old market complex in Muthialpet
- Ashram Play-ground. A common playground for the members of the Aurobindo Ashram
- School of Humanities & Social Sciences 0.9 km
- Rajiv Gandhi Cricket Stadium 1.1 Kms
- 27.07.12 jayaraj 1.2 km
- Thiruvallur Stadium 1.4 Km
- Pondicherry University Staff Quarter 1.5 Km
- Eternity, Auroville 1.6 Km
- Ivrcl (Tsunami Housing Project) 2 Km
- Siddhar Sivagaani Arts And Science College 3 Km
- Thiruvallur Stadium 0.5 Km
- Chemfab Alkalies 0.7 Km
- Pondicherry University Staff Quarter 0.9 Km

- School Of Humanities & Social Sciences 0.9 Km
- Ivrcl (Tsunami Housing Project) 1.2 Km
- Kalapet Cricket Ground (S.S.Santhamoorthy) 1.3 Km
- Shasun Chemical 1.3 Km
- Siddhar Sivagaani Arts And Science College 2.9 Km

Motorcycle Ambulances to Cut Through Pondy Traffic

Pondicherry Institute of Medical Sciences (PIMS) will soon launch ambulance services on two wheelers. This is the first time such an endeavor is being introduced in Puducherry. The reason behind this initiative is to reach accident victims in crowded locations where a four wheeler ambulance cannot easily reach. Puducherry is a fast growing town with more and more vehicles plying on the road day by day. As a result, traffic congestion in the town is getting worse. "It is an initiative to ensure first aid to the victims during the golden hour. Paramedical staff members manning the motorcycle ambulances have been fully trained in rendering first aid and resuscitation measures to save the victim at the site," said PIMS director-principal John Abraham on Tuesday, according to a TNN report.

Tourism plan

With its 32 kms Coastal line, Ashram, Auroville and Beaches, Pondicherry is an ideal place for spending holidays with families. In fact tourism is to become the backbone of the economy of Pondicherry in next 10 years of time. Pondicherry with its fascinating name has great attraction for tourists but unfortunately the tourism related infrastructure is not available at present.

Ganapathichettikulam,

The **Pondicherry Institute of Medical Sciences** is a multi-speciality hospital and teaching institute at Kalapet, in the Union Territory of Puducherry, India. The college has been approved for full recognition by for MBBS Degree granted by the Pondicherry University. Spread across 32 acres. Faculties have been drawn from all over India. PIMS has six Health Centre functioning now actively, covering both urban and rural population in and around Puducherry.

Reference

Pillayarkoil Street, Ganapathichettikulam,
East Coast Road, Ganapathichettikulam
Pudhu Nagar, Ganapathichettikulam,
Vadakku Theru, Ganapathichettikulam,
South Street (Mcsd), Ganapathichettikulam,
East Street, Ganapathichettikulam
Nadu Theru, Ganapathichettikulam,
Kuppam South Street, Ganapathichettikulam,
Dr. Abdulkalam Street, Ganapathichettikulam,
Kuppam North Street, Ganapathichettikulam,
Vallalar Nagar, Ganapathy Chettikulam,
Pims Street, Amaithi Nagar, Ganagachettykulam,

Pims Quarters, Ganapathichettikulam,
Rajagopal Nagar, Ganapathichettikulam,
Second Cross Street, Rajagopal Nagar,
First Cross Street, Rajagopal Nagar

Ganapathichettikulam is a Locality in Pondicherry City in Pondicherry State, India.

Kuilapalayam (8 KM), Auroville (9 KM), Alankuppam (9 KM), Aroma Gardens (10 KM), Irumbai (11 KM) are the nearby Localities to Ganapathichettikulam. Pondicherry, Tindivanam, Cuddalore, Vadalur are the nearby Cities to Pondicherry. It is near to bay of bengal. There is a chance of humidity in the weather.Demographics of GanapathichettikulamTamil is the Local Language here. There is no railway station near to Ganapathichettikulam in less than 10 km. How ever Chennai Central Rail Way Station is major railway station 138 KM near to Ganapathichettikulam Pincodes near Ganapathichettikulam 605014 (Pondicherry University), 605104 (Kottakuppam), 605003 (Muthialpet)

Colleges near Ganapathichettikulam

Dr. Saravepalli Radhakrishna Govt. Arts College
Address : District.:-:yanam Pondicherry--533464

Pondicherry University

Address : Pondicherry Univerity R.v Nagr ;kalapetpuducherry --605014
Achariya School Of Business
Address : Achariyapuram; Villianur; Pondicherry-- 605013
Pondicherry Institute Of Medical Sciences & Research
Address : Ganapathichettikulam; Pondicherry--605 014
Pondicherry Engineering College
Address : Pillaichacvadi; Pondicherry -- 605014; India.
Schools near Ganapathichettikulam

Kolping Mhs
Address : kalapet, brc-1, pondicherry, Pondicherry . PIN- 605014, Post – PondicherryUniversity
Maruthi Mat Hss Address : karuvadikuppam, brc-1, pondicherry, Pondicherry . PIN- 605008, Post – Lawspet
Jothi Vallalar High School Address : kalapet, brc-1, pondicherry, Pondicherry . PIN- 605014, Post - Pondicherry University

Senthil Matr.hr.sec.school Address : pondicherry, brc-1, pondicherry, Pondicherry . PIN-605001, Post - Pondicherry

Pillaichavady,

Main Road, Chinnakalapet, Puducherry-
East Coast Road, Chinna Kalapet,
Thirukulam Street, Pillaichavady,
R.V. Nagar, Chinnakalapet,

Mettu Street, Chinnakalapet,
Mettu Street-2, Chinnakalapet,
Pudhu Nagar, Chinnakalapet,
Angalamman Koil Street, Chinnakalapet,
Nethaji Street, Chinnakalapet,
University Quarters, Chinnakalapet,
Thendral Nagar, Chinnakalapet,
Aalamarathu Street, Chinnakalapet,
Nadu Theru, Chinnakalapet,
Chinnakalapet Kuppam Street, Chinnakalapet,
North Street (Pudhu Nagar), Chinnakalapet,
North Street, Pillaichavady,
Therodum Street, Pillaichavady,
Muthu Mariamman Koil Street, Chinnakalapet,
Thideer Nagar, Chinnakalapet,
Pillaiyar Koil Street, Pillaichavady,
Pudhu Street, Pillaichavady,
Adi-Dravidar Quarters, Pillaichavady,
Nadu Theru, Pillaichavady,
Puducherry Engineering College Campus, Pillaichavady,
Annai Therese Street, Pillaichavady,
Gangaiamman Koil Street, Pillaichavady,
South Street, Pillaichavady,
Throwpathiamman Koil Street, Pillaichavady,
Kannayiram Street, Pillaichavady,
Sri Annai Nagar, Pillaichavady,
Kuppam, Pillaichavady,

Siddhar Sivagnaani Arts and Science College for Men

was establilshed in 2008, with the commitment to provide quality education with strong emphasis on values and tradition and with the singular mission. The college has a dedicated team of faculty members who maintain academic excellence and about 1000 students who are the anchor to sustain the vision of the institution. The college has high standards of academic excellence and the zeal for constant updating and renewal.

Campus of Siddhar Sivagnaani Arts and Science College for Men

The College is located in a beautiful serene atmosphere near the Arulmigu Iyyanar Temple in east coast road just 8kms away from Puducherry. The college stands self contained with prestigious structures measuring to total plinth areas of 30,000 sq.ft.

Facilities at Siddhar Sivagnaani Arts and Science College for Men – Ecr .bommayapalayam

Rajeswari College of Arts & Science For Women

Rajeswari College of Arts & Science For Women, Villupuram was established by Kumaranswamy Educational Trust in 2007 with the concurrence of Government of Tamilnadu. The college is situated in a beautiful environmental atmosphere surrounded by flora at a distance of 3 kms away from the west of E.C.R. Bommayapalayam. To inculcate good principles, discipline, self confidence, ethics and moral values in the young minds of the students. There vision is to achieve economic and social equity for women through advancement and application of relevant knowledge & there mission is to sensitize there young women to their rights and place in society and through them strengthen the nation to help usher in an egalitarian society. A variety of teaching and learning techniques are employed to impart knowledge and skills to students at Rajeswari College of Arts and Science for Women in its various departments.

Rajeswari College of Arts and Science for Women
Bommayapalayam
Vanur (Tk)

Pondicherry Law colleges

Pondicherry law colleges are the reputed educational institutions to pursue higher studies in the union territory. Among the colleges in Pondicherry, the law colleges are the coveted institutes to pursue studies due to the reputation of the profession. The law colleges in Pondicherry are either Government owned or private owned. The demand to study law has increased for the past few years. The students prefer to take up this noble profession to serve the people of the nation. Thus grooming and proper education are required to shine as a successful lawyer in future. The law colleges in Pondicherry are affiliated to the University of Pondicherry. The Pondicherry Law Colleges offer degree in Master of Law or LLM. The colleges also offer the students to pursue Doctorate in Law. To pursue the research works, the candidates need to have an LLM degree secured from any recognized law college. In the Government college of Law in Pondicherry has a special course in Law. The students can pursue a Post Graduate Diploma in French Law. The Pondicherry Law Colleges have appointed the best of the faculties to teach the students. The colleges provide sufficient number of seats to the students to pursue their studies in Law. The would-be lawyers are given proper practical training and the students go through a period of apprenticeship under a senior lawyer before they start practicing in the High Courts
independently.

The popular law colleges in Pondicherry are
Dr. Ambedkar Government Law College,
Pondicherry 605001
Pondicherry

Pondicherry University,
Faculty of Law,

R Venkataraman Nagar,
Kalapet, Pondicherry 605014
Phone : 2655175/ 2655209
Fax: 2655265

Pondicherry Polytechnic Institutes

Pondicherry Polytechnic Institutes provide the students with quality education. ThePolytechnic colleges in Pondicherry offer courses that can be utilized in practical field.These institutes look forward to make each of the students of Polytechnic anindependent person. The Polytechnic institutes in Pondicherry are both Governmentowned and privately owned.

Women'sPolytechnic, Lawspet, Pondicherry-8

Sri Aurobindo International Center of Education

Sri Aurobindo International Center of Education is an intrinsic part of the Aurobindo Ashram. This institute is considered among the best Pondicherry schools. The center was established on the second of December of the year 1943. Presently there is provision for education from the kindergarten level in the Sri Aurobindo International Center of Education in Pondicherry. Excellent scope for higher education are there in this educational institution of Pondicherry. Faculties for Engineering & Technology, Sciences, Humanities, Physical Education and Languages are there in this institution of much repute. The students are also encouraged here to learn dramatics, music, various style of dance, art and crafts. The wonderfully equipped laboratories of Sri Aurobindo International Center of Education at Pondicherry provide scope of research and experiments to the students while they study. There is also a wonderfully stocked library in this educational institute.

Physical training is a very important part of education of the students of the Sri Aurobindo International Center of Education located in Pondicherry. Athletics, field games, aquatics and gymnastics are part of the regular training of the students in this school. The institution aims at helping the students in the full development of their minds as well as bodies. To achieve this target an extremely spiritual atmosphere is provided to the students.The teachings in Sri Aurobindo International Center of Education are basically aimed at leading the pupils towards perfection.

The main aim of the Sri Aurobindo International Center of Education is to impart knowledge only for the sake of it and thus no degrees or diplomas are awarded by this institute. Sri Aurobindo International Centre of Education Sri Aurobindo Ashram, Information Centre of Sri Aurobindo Ashram Cottage Complex, 3, Rangapillai Street, Pondicherry 605002 The working hours of this esteemed school are from six in the morning to eight in the evening.
Telephone: +91-413-339648

Pondicherry Kendriya Vidyalaya

Pondicherry Kendriya Vidyalaya is one of the most renowned schools in this region. It is affiliated to the Central Board of Secondary Education. In the Kendriya Vidyalaya of Pondicherry

education is offered to students from the primary to the high school level. There are two branches of the Kendriya Vidyalaya in Pondicherry. The street address of both the campuses are provided below:
JIPMER Campus, Pondicherry- 605006
University Campus, Kalapet, Pondicherry- 605014

Puducherry Engineering College

Located 12 km from Pondicherry in the town of Pillaichavady, the Pondicherry Engineering College affiliated under Pondicherry University was established in 1984. Eight undergraduate courses, eight post graduate courses and phd is undertaken by the college. The departments of Pondicherry Engineering College are:
Civil Engineering
Chemical Engineering
Mechanical Engineering
Electrical and Electronics Engineering
Electronics and Communication Engineering
Computer Science and Engineering Information Technology
Mathematics
Physics
Chemistry
Humanities

Some of the Pondicherry Engineering colleges are :

Rajiv Gandhi Institute of Engineering and Technology
Regency Institute of Technology
Bharathihar College of Engineering
Pondicherry Engineering College
SM Vijaynagar Engineering College

Pillaichavady School

Anandarangapillai Gssvh&hi, P.vady School- Pillaichavady School
Anandarangapillai Gssvh&hi, P.vady School, is situated in the village of Pillaichavady, Brc-1 Block,Pondicherry District, in the State of Pondicherry, India. Anandarangapillai Gssvh&hi, P.vady
School, Pillaichavady school information is as below:.
Management : T/Social Welfare Dept.
Village Name : Pillaichavady
Category : P + UP & Sec
Type Of School : Co-Educational
Block Name : Brc-1
Cluster : Pillaichavady
District : Pondicherry
State : Pondicherry

State highways

Goubert Avenue (East Boulevard)
S V Patel Road (North Boulevard)
Anna Salai (West Boulevard)
Subbiah Salai (South Boulevard)

There are many regular shops and shopping malls in Pondicherry, mainly located on thefollowing

Areas

Anna salai
Nehru street
Magatma Gandhi st
Cathedral street romain Rolland street
Generally,shops reain open from 10.00 to 1 pm and from 4 .00 pm to 10.00pm on Sundays many shops remain closed

Auroville

Auroville is composed of a cluster of properties some 12 km (7.5 mi) north of Pondicherry. It can be easily reached via the East Coast Road (ECR) which connects Chennai and Pondicherry. The visitor centre and Matrimandir can be reached by travelling 6 km (3.7 mi) westwards from the signposted turnoff at the ECR. Turning east leads directly to Auroville's private beach called Repos, several hundred metres away. Instead of paper and coin currency, residents are given account numbers to connect to their central account. Visitors, however, are requested to get a temporary account and an Aurocard (a debit card). Residents of Auroville are expected to contribute a monthly contribution to the community. They are asked to help the community whenever possible by work, money, or kind. "Guest contribution", or a daily fee payable by the guests of Auroville, constitutes a part of Auroville's budget. There is a system of “maintenance”, whereby those Aurovilians who need can receive from the community a monthly maintenance which cover simple basic needs of life. Auroville' economy and its overall life are of an evolving nature and there are ongoing experiments to reach closer to the vision Although the Government of India owns and manages the Auroville Foundation, it only finances a small part of Auroville's budget, which is mainly formed by contributions from Auroville's commercial units which contribute 33% of their profits to Auroville's Central Fund, and by donations. There are guest houses, building construction units, information technology, small and medium scale businesses, producing and re-selling items such as handmade paper for stationery items, as well as producing its well-known incense sticks, which can be bought in Auroville's own shop in Puducherry, or are sold around India and abroad. Each of these units contributes a considerable part of their profits to the township. Over 5,000 people, mostly from the nearby localities, are employed in various sections and units of Auroville. Other activities include afforestation, organic agriculture, basic educational research, health care, village development, appropriate technology, town planning, water table management cultural activities and community services.

Auroville Population

Although originally intended to house 50,000, the actual population today (December 2013)is 2,305 (1,763 adults and 542 minors), coming from 50 nationalities, 990 of whom are of Indian originThe community is divided up into neighborhoods with English, Sanskrit, French and Tamil names like *Aspiration*, *Arati*, *La Ferme*, *Auromodel* and *Isaiambalam*

Village Waste Management Strategy (Auroville

The Village Waste Management Strategy (Auroville) has been written to provide a co-ordinated approach to solid waste management (SWM) in the village environment. In the area directly surrounding Auroville, there are some 25,000 Tamil villagers who in total may produce up to 7500 kgs of solid waste per day. Based on figures from the nearby Panchayat of Villianur, 34.87% of this waste is either organic, and 61.57% is organic waste mixed with soil. Some of the organic fraction of this waste is fed to animals or composted close to the site of production and spread on surrounding fields. The remaining 4% (300kgs per day) is a different matter. This residual waste which consists of primarily waste plastics can be seen on roadsides, vacant land and on the outskirts of villages. These non biodegradable wastes cause a number of problems for the environment and include: · Hazardous emissions when waste is burnt · High visual impact · Incorporation of waste into the soil in large volumes causes suffocation of soil biota Waste is often contaminated with biologically hazardous wastes such as medical wastes and additional contamination occurs through materials such as heavy metals from dry cell batteries The volume and variety of non bio-degradable wastes will increase dramatically as average incomes rise and consumer items, particularly processed foods become more widespread. This will predominantly occur in lightweight packaging materials, which are not collected for recycling. The legal responsibility for collecting, storing and disposing of these wastes lies with the local municipal authority. In the area surrounding Auroville this responsibility falls to the local Panchayats. Unfortunately providing SWM services to village residents has not caught their attention to date. However this may change in the in the short to medium term. In the meantime residual waste continues to be indiscriminately dumped throughout villages and surrounding farmlands. Despite the difficulties in the past with the management of solid wastes there exists a real opportunity to redress this as a result of a number of new initiatives being undertaken by local NGO's. The first is a small pilot project in the village hamlet of LakshmiPuram in Kuilapalayam, which is being managed by Auroville Clean and Beautiful. In this project community bins are being provided for the collection of residual waste. The second project is another pilot being launched in the village of Thuruvai where Exnora and AVAG will look at the feasibility of introducing a door to door collection system.

Anna salai

Indira Gandhi National Open University branch in Anna Salai Office GNOU Regional Centre Chennai, one of the largest Regional Centres in the country was established in the year 1988 for serving the educational needs of the people in the State of Tamil Nadu, Union Territory of Pondicherry and Andaman & Nicobar Islands

Annasalai hotels

Anandha Inn

Hotel Abirami Residency
Hotel Ram International
Annai Residence
Shri Perumal Inn

Auto fare protest: Times of india magazine

PUDUCHERRY: Civil society groups, general public and tourists took exception to the Puducherry government's decision to fix 'exorbitant auto fares' in the Union territory without seeking the opinion of the users.On December 23 last year, the Puducherry government passed an order revising the minimum fare at Rs 15 for the first 1.8km on the lines of what the Tamil Nadu government did in August. However, People's Pulse - a forum that joined the Alliance for Good Governance to launch a campaign to regulate auto fares in the Union territory -- said the Puducherry government fixed 'exorbitant fares' for every additional kilometer, unlike in Tamil Nadu. The form criticized the government for fixing 'unreasonable waiting charges' and for not relaxing the night service time. In August last year, the Tamil Nadu government revised the minimum fare of autos, fixing Rs 15 for the first 1.8 kilometer and Rs 12 for every additional kilometer. The Tamil Nadu government fixed Rs 3.50 for every five minutes as waiting charge and even relaxed the night service time from seven hours (10pm to 5am) to six hours (11pm to 5am). However, the Puducherry government fixed Rs 15 for every additional kilometer. Moreover, it fixed Rs 20 as waiting charge for 30 minutes and failed to relax the night service to six hours, the forum said. According to the forum, the fares in Puducherry are much higher than those in Tamil Nadu, Kerala, Andhra Pradesh and Karnataka. Ironically, fuel cost, road tax, value-added tax and renewal of permits and other necessary licences are less in Puducherry, compared to those inother southern states. "A 10-km trip in an auto in Chennai or other big cities and towns will cost roughly Rs 120 while a 10-km trip in Puducherry will cost Rs 150 even though the cost of living, fuel cost, road tax, value-added tax and other licensing expenses are the lowest in the Union territory when compared to other states," said People's Pulse president S Hemachandran. The forum has launched an online campaign to mobilize support from like-minded organizations, general public and tourists to pressurize the government to revoke the 'exorbitant hike' and conduct a public hearing to re-notify nominal fare. It said the government should supply fare structure tables to all auto drivers and ensure that all autos have meters.

The forum urged the government to direct the drivers to display the details of the permit, ownership and drivers with photos and phone numbers of grievance redressal and regulatory authorities duly certified by the transport department. Moreover, the drivers should wear uniforms, badge and their name plates. The forum urged the government to notify auto stands and remove illegal ones. It said the government should seize all the autos plying without valid permits and initiate action against drivers on users' complaints. The forum demanded the government introduce prepaid autos from railway station, bus stand and government hospitals. It urged the government to sensitize the auto drivers to behave courteously towards the public.
Courtesy: Times of India.

In the past few years, there have been a number of problems regarding auto fares in Puducherry with several complaints of auto drivers overcharging and not using their meters

coming in. In order to improve auto travel in the area, the Transport Department has now taken a decision to take suggestions from the various stakeholders. The general public, auto drivers, autorickshaw unions and other stakeholders have been invited to send in their views on the auto fares and how it can be revised to improve the situation. These views will then be compiled and a decision will be made on the revision of fares, a release said. So far, the fares that have been approved by the government were fixed in 2009. During the daytime, the minimum is Rs. 20 for the first two km and Rs. 10 for every subsequent km. Waiting charges are Rs. 10 for every half an hour. Since then there have been several changes and now, the auto drivers are demanding higher fares, which is an inconvenience to the public. It is, therefore, necessary to understand the demands of the auto rickshaw drivers, unions, as well as the general public, in order to come up with new fares, an official from the Transport Department said.

The Department has been accepting views from various stakeholders since September 23 and will continue to do so until Friday. According to the local auto drivers and the unions, however, the fixed amounts need to be increased, since, they say, they do not account for the rise in fuel prices and other factors. Unlike in larger cities like Chennai, the distances are not very long, and so, for an auto driver to make a living, the fares need to be a bit higher than the bigger cities.

Puducherry has a total of 3042 (approximately) auto rickshaws that have been registered with the Transport Department. However, not all of these may be in active service. The Transport Department is attempting to ensure that auto travel is both safe and affordable for the general public and tourists that visit Puducherry, the official said. Stakeholders can hand in their views in writing at the Transport Department or emailwww.tc.pon@nic.in.

- Puducherry Bus Stand
- Jayendra
- Hotel Vijayentra
- Local Bus Terminus
- Anandham Residency
- Church of the Sacred Heart of Jesus
- Puducherry
- Money Gram
- Church Of Our Lady Of Immaculate Conception
- Athiti Hotel
- Nilgiris
- Bharathi Dasan Women's College Bus Stop
- Casablanca
- Kalatheeswaran Kovil
- JP Cycle Store
- Hidesign
- Sri Manonmani Amman Cycle Store
- Satsanga

- Creole
- Richie Rich
- BP Petrol Pump
- L'e-Space
- All Women Police Station
- Hot Breads
- New Guesthouse
- Citi Bank (24 hours)
- Rendevous
- Aurbindo Bus Stop
- International Guest House
- A2B
- Head Post Office
- Sri Manakula Vinayagar
- Madame Shante's
- Sri Aurobindo Handmade Paper
- Hotel de Pondichery
- HP Petrol Pump
- Park Guesthouse
- Sri Aurobindo Ashram (Mother Samadhi)
- Ajantha Beach View
- Nnotre Damme de Agnes
- Sri Aurobindo Ashram Sub Post Office
- Dr. B.R. Ambedkar Library
- Murungapakkam Villianur Road
- Cuddalore-Puducherry Administrative Boundary
- Villupuram Pondicherry Nagapatinam National Highway 45A
- Muthirapalayam Road
- Mettupalayam Link Road
- Nilaya Street
- Vazhudavoor Road
- Tindivanam Road NH 66
- Villupuram Puducherry Nagapattinam National Highway 45 A
- Kanakan lake road
- Aarudra Nagar
- Pondicherry Airport
- Veerapattinam Road
- Cuddalore Road
- Karamanikuppam Road
- Maraimalai Adigal Salai
- Puliansalai Road
- Kosapalayam Road
- Ellapillaichavady Road
- ECR (Chennai Road)

- Kamaraj Salai
- VVP Nagar
- Mill Road
- ThenanChalai
- Subbiah Salai (South Boulevard)
- Venkata Subba Reddy Square
- Savarirayalu St
- Petit Canal St
- La Porte St
- Thillai Maestry St
- Bharathipuram Rd
- Bus Depot
- Aquarium
- Pondicherry Botanical Gardens
- Stolen Building
- Another stolen place
- Anna Salai (West Boulevard)
- Lal Bahadhur Sastri Road

Survey on for better mobility

Armed with questions on mobility, ease of access, safety and other parameters, volunteers of the Delhi Integrated Multi-Modal Transit System Limited (DIMTS) have been undertaking surveys among residents and tourists for preparing the Comprehensive Mobility Plan (CMP).
The Puducherry government had awarded the work of preparation of the CMP to DIMTS, New Delhi. On Saturday, volunteers directed their questions at tourists on Beach Road to design a tourist-friendly CMP. Questions were about pedestrian space, mobility, public transport and safety. The surveys are expected to provide answers on origin and destination of tourists, traffic volume and tourist inflow. The survey will be useful to various stakeholder government departments such as the Department of Tourism, Transport Department, Local Administration Department, the Puducherry Road Transport Corporation and the Regional Transport Office, said Ram Kumar, Assistant Manager-Transport Planning, DIMTS.

With a large number of domestic tourists coming to Puducherry by private vehicles, especially from Chennai and Bengaluru, surveys are also being conducted at petrol pumps. “Our team will be looking at how more areas can be made non-motorized as we have observed safety issues in the tourist areas. We will also be looking at improving bus service accessibility in the town,” said one of the volunteers. The Hindu Magazine

16-Global Multinationals and Puduvai Trans System

Most of these civil works or supply of equipments are made by global multinational companies or major civil contractors in the Country. A list of the major contractors/suppliers of Puduvai Trans.

Design & Construction of Civil Works
Hindustan Construction Company, India.
Larsen & Turbo, India.
Samsung Corporation.
IRCON International, India.

Rolling Stock
Siemens.
Bombardier.
Mitsubishi Corporation, Japan.
KORES, Korea.
Mitsubishi Electric Corporation, Japan.

Signaling
Alstom Transport Ltd India
Alstom Transport, France
Alcatel Portugal SA

Power Distribution/Traction etc
ABB India
Best & Crompton

Automatic Fare Collection
Alcatel CGA Transport, France

ABB solutions for solar energy Solar technologies for power generation
Environment friendly energy is one of the biggest global challenges we face today and major companies are at the heart of this issue. This is because the world expects them to come up with new technologies and systems to produce energy with reduced pollution and greenhouse gas emissions, widely recognized as one of the main causes of global warming.
Solar energy can be used to generate electricity either directly using photovoltaic panels, or indirectly using solar thermal panels to produce heat which is then converted into electrical power. In both cases, maximum yields can only be achieved by adopting equipment and components that guarantee the highest levels of quality with a range of products wide enough to meet the needs of every kind of plant.

Boallttasgeo Marine Consultant

To introduce ourselves as one of the leading Geotechnical consultants based in Chennai. We have been in continues operation since 1994 and have carried out various geotechnical engineering works for the projects of Government Organizations and for the private sectors throughout India. Our work has been carried out in full co-operation with our clients and to their entire satisfaction

- Topographic / Hydrographic Survey.
- Site Investigations.
- Soil sampling using rigs on land in marine condition, river beds, back water, reservoir and in Open sea.
- Rock core drilling,
- Offshore Drilling.

Drilling & Grouting field test such as standard penetration test, Static cone penetration and dynamic cone penetration test, Plate load test and the like,

- Laboratory test on soil and rock.
- Analysis and collation of test results.
- Foundation designs such as for pilling etc.
- Design for ground improvement works (rammed stone columns and drains etc).
- Reports on investigation Mobile:
- +91-9444773802, +91-8124095900 Phone: 044- 42134581, 044 - 43548791, 044-32425113

Valecha Engineering Ltd

Valecha Engineering Ltd., is an ISO 9001:2000 certified company presently lead by Mr. J.K. Valecha and engaged in civil engineering. Established in 1957, Valecha Engineering Ltd is a significant beneficiary of the infrastructure thrust witnessed by the Indian sub-continent, mainly in the road development sector. The company listed in the Bombay stock Exchange has created some of the most prominent civil engineering infrastructure landmarks of India and has positioned itself as a globally accepted construction and infrastructure development company Valecha Engineering, a leading player in the construction industry having a Group Turnover of Rs.3000 Million, is engaged in the construction of major infrastructure & engineering projects such as Irrigation Dams, Reservoirs & Canals, Roads, Highways & Expressways ,Bridges & Tunnels Railways, Airports, Foundation & Piling Works.

Thank You.

17-Working Model- Snapshots

Snap Shot Pictures of the Working Model for the Maglev Magnetic Two –Tier Monorail Rapid Transit System