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Sky Bus: The Modern Transportation System

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ABSTRACT

Sky bus Metro is a suspended railway invented by Indian technologist Mr. B Rajaram. Now in metro cities like Hyderabad, Mumbai, Bangalore, etc., the number of problems developing regarding transportation due to increase in population India, mostly in these cities. The problems are overload on public transport system, increasing vehicles (two wheelers and four wheelers) Sky bus is necessary to reduce overload on public transport system. And due to increase in vehicles the number of problems developed likes Traffic jam, Accidents, Pollution etc. So that by constructing the sky bus metro reduced this problem. Thus sky bus metro solve the public transportation problem in metro cities. After experiencing congestion's and traffic jams over three decades, India finally realized her urban public transport system requires transformation for solving several problems at once and for long term. Innovation of Sky bus by Indian Railways, a Govt. owned enterprise is the outcome of this learning process. Sky bus project has been receiving support from Government, Industries as well as from various public in India. This research confirms the advantages of Sky bus innovation are tremendous.

For overpopulated Indian urban areas, Sky bus seems to be the best solution for safe, quality and inexpensive mass public transportation system. After approval from concerned authorities, Sky bus will be the long term solution for public in terms of transportation in India.

Sky Bus metro is in the tramway category, under Art 366(20) of the Constitution of India. Since it parallels existing roadways and within municipal limits, it is excluded from the Act. Sky Bus cannot capsize or collide. Sky Bus is based on the concept of "Sky Wheels" presented in 1989 at World Congress for Railway Research. Sky Bus eliminates vandalism, derailments and is virtually maintenance free. Construction cost Rs 450,000,000 per km. It is noise- free & pollution-free with no crossings. It can carry about 18000 people per hour per direction (pphpd), scalable to 54000 pphpd as required. Which are suspended from bogies and travel below rail guides, the physics of which can be engineered very easily shells of coaches and suspension links well proven. Prefabricated latest construction technologies, which save time and money resulting in easy execution of the project in busy urban areas without disturbing the existing traffic pattern .These structural engineering methods, are well proven which do not have any project execution risk attached.

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INTRODUCTION

Sky bus Metro is a suspended railway invented by Indian technologist Mr. B Rajaram. Sky Bus metro is in the tramway category, under Art 366(20) of the Constitution of India. Since it parallels existing roadways and within municipal limits, it is excluded from the Indian. Sky Bus cannot capsize or collide. Sky Bus is based on the concept of "Sky Wheels" presented in 1989 at World Congress for Railway research. Sky Bus eliminates vandalism, derailments and is virtually maintenance free

A. Growth of Indian Urban Population

Although India occupies only 2.4 per cent of the world's land area, it supports about 16 per cent of the world's population. Only China has a larger population. Almost 40 per cent of Indians are younger than 15 years of age. About 70 per cent of the people live in more than 550,000 villages, and the remainder in more than 200 towns and cities. Over thousands of years of its history, India has been invaded from the Iranian plateau, Central Asia, Arabia, Afghanistan, and the West. The magnitude of the annual increase in

population can be seen in the fact that India adds almost the total population of Australia or Sri Lanka every year. A 1992 study of India's population notes that India has more people than all of Africa and also more than North America and South America together. Between 1947 and 1991, India's population more than doubled.

According to census of India in 2001, out of the total population of 1027 million about 742 million live in rural areas and 285 million in urban areas. The net addition of population in rural areas during 1991-2001 has been to the tune of 113 million while in urban areas it is 6 million. The percentage decadal growth of population in rural and urban areas during the decade is 17.9 and 31.2 per cent respectively. The percentage of urban population to the total population of the country stands at 27.8 per cent. The percentage of urban population to total population in the 1991 census was 25.7 per cent. Thus, there has been an increase of 2.1 per cent in the proportion of urban population in the India during 1991 and 2001. India has four cities with population more than 10 million.

B. Indian Urban Transport

In India, transportation demand in urban areas continues to increase rapidly as a result of both population growth and changes in travel patterns. As it enters the 21st century, the urban areas in the country confront a historic transportation crisis that has become a planning war against increasing mobility gridlock and air pollution. Given the financial restrictions and environmental concerns, it appears unlikely that this demand can be accommodated without dramatic changes in travel behavior. The principal urban transportation policy needs to adopt a comprehensive strategy for achieving mobility and air quality mandates.

In the absence of a good, convenient and efficient public transport system in urban areas, there has been an increasing trend towards more and more ownership and utilization of personalized motor vehicles to commute which is not only more energy intensive and polluting, but also more expensive to the economy. While on one hand, the vehicle mix in urban areas has aggravated congestion and air pollution, on the other, specifically production of buses and their design for mass transportation has not received adequate attention in the national automobile policy. With growing traffic congestion, thousands of dismayed drivers in the urban areas are finding out that rush hour traffic is slowing to a crawl. This in turn leads to higher oil consumption and emissions which are poisoning the urban areas. India has been facing serious difficulty of urban congestion and traffic jams since 1970's in her major cities. Public transport system in Mumbai has been overworking three times its capacity. Public transport system in Delhi, Calcutta and Chennai is also under strain.

The pressure on the Mumbai rail system is all the worse because the population growth has been concentrated in the suburbs. This means that the rail network has to cope with increasing numbers of commuters. The dominant feature of commuter movements in Mumbai is the overwhelming dependence of the travelling public on the suburban railway services of two zonal railways, the Western railway and the Central railway. As much as 73 per cent of passenger kilometers are covered by the suburban railway system as compared to the 27 per cent of bus and 20 per cent of private vehicles and taxis. The most precious asset in growing urban areas is the land. Allocation to residential and commercial purposes put heavy pressures on land for public use like parks and open spaces apart from very important and critical roadways. Hardly 6 per cent to a maximum of 18 per cent of land in cities form roadways. The roadways once laid, almost remain constant. The physical constraint of road area being constant, as population increases, naturally loads on roads increase.

C. Innovations and Advantages of Sky Bus

Indian Railways studied these options and recognized the fact that they should have all problems solving solution. After long research of more than 20 years, under the leadership of B. Rajaram a team of professionals and researchers innovated sky bus system for urban public transportation. Indian Railways acquired worldwide patents during 2001 and 2004 for sky bus. These patents stand assigned to the president of India. Sky bus system in latest innovation in urban public transportation and has special advantages which are explained as follows:

1. Sky bus follows the existing roads but does not take road space and is as flexible as abus
2. Has rail based mass transit capacity, same as existing rail metro
3. It does not divide city while providing integration along its alignment
4. Sky bus is derailment and collision proof and has no capsizing of coaches so that therecan neverbe loss of life
5. It is free from vandalism
6. Noise free and pollution-free
7. Sky bus is non-invasive and requires the least amount of scarce land space and it doesnot come in the way of development.

D. Improvement in Urban Public Transportation

As more and more people from different habitats try to converge on to the central business district, the road has no capacity to handle and congestions erupt. Roads takeone exactly to the point where one wants to go. But the capacity is limited in terms of passengers per hour that can be handled. Even if one considers only buses, need tomaintain the braking distances between two buses and the space maintained between them affects speed as well as limits per lane what capacity can be achieved. When mass transit, that too at higher speed is required, rail based systems only can handle. Indian Railways considered different options for permanent improvement in urban transport system but none of these options could give perfect solution. Following were the major options:

Elevated railway technically cannot reach truly congested central busy roads where the mass transport is needed. It is also too invasive and may require dislocation of some portions of habitat as well as introduces noise pollution. Underground railway is less invasive on surface but still poses technically challengingrisks of fires and evacuations. It also has to address concerns for foundations of heritage buildings. If road vehicles are involved, in inter-modal transfers, it becomes weak link in the chain of transport between walking and railway. Both modes suffer from derailments and capsizing killing commuters. Surface railway is impossible to lay in an existing city. But even to lay the same in a new development, one should keep in mind what happens after 50 years of laying the same. India has example of her own suburban system. The city remains divided by the corridor and it is an eternal noise polluter in the heart of city day in and day out. Sudden disgorging of heavy loads of commuters at stations createneed less congestion on the roads,

Reducing quality of life. Almost close to 2000 persons die annually- because of trespassing or falling from trains in present Indian system, whatever be the excuse and justification for accepting the same. In addition vulnerable to minor vandalism by urchins, but resulting in grievous injuries like losing sight forthe commuters. Also this mode cannot follow roads, so the weak link of road vehicles has to be brought in for inter-modal transfers. Derailments, collisions and capsizing concerns remain with loss of life for all the above mentioned three Systems.

E. Implementation of Sky Bus Project In India

The Ministry of Railways has allocated funds to put up a 1.6 kilo meter test track. All elements of the technology which make up the sky bus have been well tested. What needs to be tested is only the system integration. By July 2004 the test track is expected to clear doubts of experts and then onwards, without government support by way of funds, any private industry can put up the sky bus project. The benefits of sky bus system are tremendous however; high project cost is a great impediment for implementation of the project. This completely indigenous design of the sky bus has attracted a consortium of thirty four companies to realize the prototype. Some of the corporate giants of India extended support to the trial run of the sky bus urban transport system piloted by Indian Railways. Indian Railways has initiated discussions with the Austria-based firm, Elin EBG, for installing gearboxes to the motors that are to drive the sky bus. The Austrianfirm has offered to supply some motors and electric components required for the sky bus free of cost. It has been scheduled to conduct the first trial run of the sky bus during July 2004.

In spite of receiving support and approval from various government and non-government organizations sky bus project has been going slow. Indian state governments and city corporations hesitate to be the firsts in implementing this project. The reason is, sky bushas not run yet. Sky bus has to pass the track test. Four Indian states and few city corporations are ready to implement sky bus project as soon as track tests are approved by the However, present environment is also favorable for sky bus project. India is ready for development.

India's development strategy and economic policy are guided by the objectives of accelerating the growth of output. Though India is a largest democracy in the world with multiparty government, there is today recognition that in many areas of activity, development can best be ensured by freeing them of unnecessary controls and regulations and withdrawal of state intervention. India has one of the largest industrial sectors in the world, and ranks amongst the top 10 nations in the production and consumption of a wide array of products and services. These facts makes it clear that, if sky bus project receives approval by experts for its track tests, sky bus will become the solution for urban public transportation in 21st century at least for India.

SKY BUS METRO TECHNOLOGY

A. Sky Bus Metro

Sky Bus Metro is latest, economical, eco-friendly, reliable and most innovative but Simple technological solution developed by Konkan Railways as a rail based Futuristic Urban Mass Transit System. It is free from derailments and collisions and therefore very safe. It can be

constructed on the median of the road without affecting road traffic.

The typical structural configuration of the Sky bus railway consists of 1m dia. concrete columns about 9m tall, spaced about 10-15m apart supporting a continuous box structure about 9m wide, cantilevering equally on both sides of the columns. These cantilevered portions of the box structure has got a continuous slit through which the passenger carsare suspended from the bogies above, running on the rails which are concealed in thebox. These columns are usually placed in the median space of existing roadways, thus enabling the sky bus route to follow existing road pattern.

The sky bus metro is considered an efficient and cost effective type of metro railway. The major advantage of this system is that it eliminates the possibility of the train escaping the track and capsizing. This enhanced stability is achieved by lowering thecenter of gravity by suspending the car. If at all derailment happens, the bogie cannot escape the track as it is contained in the box structure.

Fig. 1: Sky Bus Metro

B. Necessity of Sky Bus in Metro City

1. Population Explosion

Population explosion is the most serious problem facing our country today. For the European developed countries like Spain and Italy, where the population is decreasing, this might be considered as a boon. However, for the developing countries like India, population explosion is a curse and is damaging to the development of the country and its society .The population of India increases day by day. As the birth rate increases and death rate decreases. Now the population of India reached to 1,241,491,960. The graph shows increase in population. In metro cities like Bangalore, Kolkata, Hyderabad, pune, the population increases day by day due to migration of people. The migration plays an important role in increasing population in metro cities. The people from village or rural area migrate towards cities for searching a job or for education .due to this population increase in metro cities. As the population increases by this growing rate, the numbers of problems are developing mostly in metro cities. One of the most serious problems is increasing vehicles in metro cities.

2. Overload on Public Transportation System

Fig. 2: Overload on Public Transportation System

In metro cities, the population increases day by day. As increase in population number of problems developing. One of the most important problems regarding transportation is overload on public transport system. For this increasing population public transport system becomes shorter. The public transport system in metro cities like local train, city buses are overloaded. The following photograph shows overload on public transport system.

3. Increasing Number of Vehicles

As population increases, the numbers of vehicles (i.e. two wheelers and four wheelers) are increases now a day. The population in metro cities grows rapidly so that the number of vehicle is increasing in metro cities. Increasing vehicles is the most serious problem because in metro cities the volume of vehicle are increasing fast but the roads are become shorten for this increasing volume. Due to this the numbers of problems are developing Such as traffic, accident, pollution etc.

C. Advantages of Sky Bus Metro

1. **Fast Transportation:-** Every two - three minute passengers to get Air Conditioned up to 100 km/h speed travel facility, covering distances at about 45 km/hr average speed.
2. **Minimal Land Acquisition Problems:-** In this new technology of `Sky Wheels', Minimal land acquisition will be required, except for providing for right of way on existing roadways.
3. **No Vandalism: -** Not vulnerable to vandalism on track / moving gears are inaccessible.
4. **No capsizing: -** If at all derails, cannot fall down

coach keeps hanging. Hence no capsizing takes place as compared to railways and underground metros.

5. **Capacity: -** Can handle 6000 – 9000 PPH (Persons per hour per direction) (One Sky Bus consists with two – three minutes head way).
6. **No Pollution: -** Aesthetically pleasing & no noise pollution, environment friendly.
7. **No waiting:-** There is a Sky Bus every 2/3 minute.
8. **Comfort: -** All Sky Buses are Air-conditioned giving you excellent comfort of traveling.
9. **Amenity: -** Senior citizens and differently enabled persons have lift facility
10. **Luxury: -** Clean and comfortable cafes, business centers, restaurants and communication facilities with health parks made available on Sky-Top, thus adding to urban space.

CASE STUDY OF GOA SKY BUS TRACK PROJECT

A Konkan Railway carried out a test track of sky bus in Madgaon, Goa with the help of Goa state government. The details of test ride are as follows:-

1. Length of test track 1.6 km
2. Maximum Test speed – 100 KMPH
3. Steepest gradient 1 in 50 (2%)
4. Radius of sharpest curve - 100 m
5. Radius of flattest curve - 875 m
6. Maximum radius of vertical curve - 3375 m

The test track for Sky Bus Metro was being constructed at Madgaon in the open area along the Railway Track along the Railway Track near Madgaon Station. The test track geometry has been designed to demonstrate the dynamic behavior of the Sky Bus Metro

i.e. the oscillations of the coaches, rail wheel interaction etc. and the cutting edge technologies proposed in Sky Bus Metro. The target for completion of the test track is October 2004.

A. Accidents in the Project

September 25, 2004 was a sad day for B Rajaram of Konkan railways. During a test run of his dream project - the Skybus - there was an accident, the skybus overspend and hit a pole. One died and two others were injured. "The accident most likely occurred because the bogey was heading at a higher speed than it should have. Also it oscillated to a higher degree than we had expected," KRCL MD B Rajaram, told PTI. The Skybus does not really need a driver or an operator. When the Skybus approaches a station, it is supposed to slow down by itself and stop. The brake is only for emergency usage. In this case, the Skybus did not slow down, and the Control room threw the emergency brake which resulted in the accident. The accident happened on the 1.6 km test track prepared for the Skybus.

B. Positive Points Which Emerged in this Unfortunate Accident

1. It is important to note that in spite of such impact forces, the people inside the coach were not crushed to death due to coach collapsing / capsizing. They survived the crash.
2. The suspenders did not fail, only got bent, but held positively the coach suspended, and so did not fall down on to the ground. This is as per our expectations.
3. The wheels did not derail but remained on track which is a positive point and again design has proven right.
4. So unlike in a conventional railway system, Sky Bus proved to be safer indisaster.

C. After Accident

"It was an unfortunate accident, but then, human beings learn from their mistakes. The way we have modified the Skybus, the original design factors are still satisfied and more safety features have been included. It's now 99 per cent complete and its safety has been proven,"Rajaram Bojji said. The test track of the Sky Bus Metro of the Konkan Railway Corporation Ltd., in Goa, which was suspended due to an accident on September 25 2004, is resumed after 3 months. The Central and Goa Governments are funding the 50-crore test sky bus project which resembles a bus hanging from a bridge. Several private sector companies are contributing to the experiment by giving free material. The mishap definitely threw Konkan Railway on the back foot. After all, this happened only a few days after a throng of journalists had witnessed the successful test run of the Skybus. That moment of triumph for Konkan Railway was quickly followed by thisaccident

D. Riding Characteristics

1. Vertical

Speed kmph	Max. Acceleration	Riding Index	Appreciation
30	0.058	1.883	Almost very good
40	0.069	2.131	Good
50	0.106	2.260	Good
60	0.101	2.244	Good
70	0.122	2.692	Nearly Good

2. Transverse

Speed kmph	Max. Acceleration	Riding Index	Appreciation
30	0.028	1.669	Almost very good
40	0.035	1.810	Good
50	0.047	2.008	Good
60	0.047	1.993	Good

3. Longitudinal

Speed kmph	Max. Acceleration	Riding Index	Appreciation
30	0.096	2.361	Good
40	0.104	2.362	Good
50	0.094	2.254	Good
60	0.108	2.323	Good

CONCLUSION

After experiencing congestions and traffic jams over three decades, India realized her urban public transport system requires transformation for solving several problems at once and for long term. Innovation of sky bus by Indian Railways, a government owned firm is the outcome of this learning process. Sky bus project has been receiving support from government, industry as well as from various publics in India.

This research confirms that the advantages of sky bus technology are tremendous. For over populated Indian urban areas, sky bus seems to be the best solution for safe, quality, and inexpensive mass public transportation.

Indian state governments and metro city corporations are waiting for final approval from experts. If sky bus project receives approval by experts for its track tests, sky bus will become the solution for urban public transportation in 21st century, at least for India

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