

Research Article

An Innovative Concept of Skyscraper Bus: the Environmentally Optimized Solution of Mass Transportation to the World's Megacities

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Abstract

This paper presents a new concept of solving the problems of 21st century's megacities of the planet. Bangalore, Mumbai, Cairo, Dubai, Bangkok, Dhaka, Addis Ababa, Lagos and other great cities are getting chaotic by the day in spite of plethora of facilities. The cities of the planet are growing like monsters in an unstoppable way. This is putting tremendous strain on the complete spectrum of resources including road space, building materials, pedestrian walkways, healthy quality of life of citizens, water bodies, parks, open spaces etc. The Skyscraper Bus concept is an attempt to optimize the space domain of our cities. People are increasingly getting impatient with never ending building works in the cities including for metros, flyovers, bridges, tunnels, pavements etc. This bus is an attempt to leverage the vertical dimension to free up the precious real estate for not more and more construction but for better "green and fun" enjoyment by citizens of the megacities. This will lead to the victory for pedestrians and cyclists. This will also lead to more greenery which will help bequeath rich green and environmentally sustainable legacy for future generations.

Keywords: Skyscraper Bus, Environmentally Optimized Solution, Vertical dimension, Mass Transportation, Megacities, Planet

Introduction

The world population is growing steadily year on year. At the current rate it has been predicted that world population will be 9 billion in 2040. With the ever increasing population it is but natural that cities will be adding more and more number of people. This will require massive build-up of housing, roads, shops, multiplexes and other facilities. Also, transportation will also be required to catch up with this explosive growth.

Though all world's cities are now having mature bulk/mass transportation systems and many more are poised to get more such bulk systems there are indeed constraints.

Even though cities have enlarged more and more in area, however, it is indeed still a challenge to move people in the Central Business Districts/Core areas and high density corridors. Lot of road density is consumed due to more number of chaotic matrixes of vehicles including buses, cars, rickshaws, bicycles etc. especially in Asian cities. Straddle Bus concept being trial tested in China has received wide publicity recently.

It is proposed to free our cities roads and bring back the pedestrians to have fun and safely while they shop, work, eat, enjoy, gossip on the move.

To enable this new concept of Skyscraper Bus is proposed here

Concept

In a city like New York there is a Manhattan. In a city like Mumbai there is Nariman Point and Cuffe Parade. These areas are in core areas having multitudes of skyscrapers. The houses are packed virtually tight like sardines. It is a felt need to have a huge & tall bus which will occupy less road space but transport large number of people in our megacities where population density is high. These buses will be used in city core and high density routes.

Advantages

An advantage which shall accrue with this Tall Bus is as under

- Occupation of less Road space. People can head to the workplaces straight without taking any lifts (of course buildings will also have to invest to cater for this paradigm)
- Freeing up space for pedestrians to enjoy the cities buzz/markets/street scene etc. (That was the original purpose of roads, today a pedestrian feels

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- it dangerous to be near the roads in cities like Delhi.)
- Tall Buses will save huge infrastructure
- Development/maintenance costs of roads.

Companies can save their advertising costs by targeting only these buses where footfalls & eyeballs will be more.

Disadvantages

Having seen the advantages we will also discuss certain disadvantages also.

These could be

- Huge Developmental cost of this bus. (This Bus will be like a jumbo jet version of airplanes but in vertical dimension/alignment)
- Matrix of several types of Engineering/Science will be required.
- It may not be appreciated by older generation people/senior citizens.

- Vulnerable able to terrorist threats. (However, with good security architecture this may be mitigated)
- Volumes of Buses required may be less. Hence, businesses may feel it not attractive due to low volumes of manufacturing. (However, with attractive pricing and package of maintenance & spares back up could be considered viable by businesses)
- Speed of the Bus may not be too high. Restrictions will have to be enforced/lived with.

Challenge – Solution Matrix

For any new concept there are always challenges and naysayers. However, there are certain coherent/logical/tangible answers to them. In the Present proposed concept, an innovative methodology of Skyscraper Bus has been outlined. Though double Decker buses have been common since last century, however, nobody has thought of extending this concept for higher and higher traffic density routes for transporting passengers in bulk in the megacities of the world. FAQ Matrix is outlined below.

Sr. No.	Naysayers Questions	Solution finder’s Answers
(a)	Why have tall Buses when we have lived with small buses for decades?	Cities are getting increasingly congested. This Bus will free our cities roads. Less congested roads will be environmentally responsible and give pleasing uncluttered look and feel.
(b)	Tall Buses are dangerous. Imagine I am on 24 th module of Tall Bus. I will get scared.	Not dangerous. Today people are living in buildings with heights of almost 800 meters. (Let Engineers take care of Technicalities)
(c)	It will be only for utilitarian needs. No fun will be involved.	Wrong. In addition to utilitarian requirement, fun element will be there. (Imagine BurjKhaleefa “moving” on the Dubai beachfront It will be a great feeling)
(d)	It will need stronger materials than are available.	Wrong. The materials used will be steel as well as new generation materials
(e)	Will the Tall Buses be possibly being having other Customers?	Why not? Big retailers may not like to lock in their assets at only one place. They can go in these “bus buildings” to several locations of the City. Also some Govt agencies may be better able to work from these buses rather than being permanently fixed in one location. The world is mobile .So should be the offices also.
(f)	Will it require development of new technologies/requirements?	Bus may require heavy tires, heavy engine, massive hydraulic shock absorbers, hydraulic power steering etc. But there seem to be no challenges which cannot be surmounted at this juncture of time.

Salient/Peculiar Features of Bus

The Skyscraper Bus will have peculiar features. These include

Engine Module:- It is appreciated that an Engine of Desired calculated load capacity will be required to tow/move/run the bus. An engine of any large ship or aircraft can be customized to the requirement of this Tall Bus. Also the engine may be powered by diesel or CNG and shall be designed to minimize oil changes.

Transmission

The operation of the transmission must be fully automatic it must comprise a torque converter in

combination with multi ratio gear box. Hydraulic systems will tremendously give huge mechanical advantages.

The transmission selector must be of push button type located to the right of steering wheel/joystick and separate button for forward movement, neutral and reverse movement is required.

Steering

This is going to be a major challenge for designers. However, Robotic assisted steering can be incorporated for this Tall Bus. The steering system will leverage the coordinates/latitude/longitude for effective steering. Tyre Geometry can be worked so

that tyres run/turn in any direction effectively and as per GPS enabled system.

The bus must be fitted with power-assisted steering which permits manual steering in the event of failure of power-assistance.

Braking System

Massive Amount of Braking effort will be required to stop the vehicle any time. Hydraulic Braking system will be appropriate. This can be duplicated/ triplicated to ensure adequate redundancy in the system. Fail safe systems must be catered in all circuits. The braking system consist of following parameters

- The Bus must have disc brakes on all axles
- Brake pad wear limit indicator must be fitted.
- Must be fitted with electronic Anti-Lock Braking (ABS) on all wheels.
- A self parking brake must be fitted on each Bus.
- A disc pad must be providing a minimum service life of 25000Km- 300000Km when used in normal operations before replacement is necessary.

Tyre

To take such a massive tall structure, tyres will have to be of massive size.



Fig.1 Tyre Design

- All wheels are to fitted with steel rims.
- Preferred tyre size is 295/80R 22, However, alternatives will be considered
- All wheels and tyres must be identical and interchangeable between all wheel positions.

Lift Modules

Tall Bus will have an Integral Lift Facility wherein the Lifts will take people up and down continuously. The power requirement for this can be met by Generator cabin of Engine Module. Existing Lift Design from reputed elevator companies will be sufficient.

Tilt/Incline Compatibility

However the Tall Vehicle faces a slant/incline/tilt at any location of city e.g. flyovers etc. This Tilt/Incline Compatibility feature will come handy. It will auto – correct/auto adjust the bus so that passenger’s get a feeling of being totally on horizontal ground even though they may be in tilted condition.

Suspension System

Fully active suspension systems use electronic monitoring of vehicle conditions, coupled with the means to impact vehicle suspension and behavior in real time to directly control the motion of the bus.

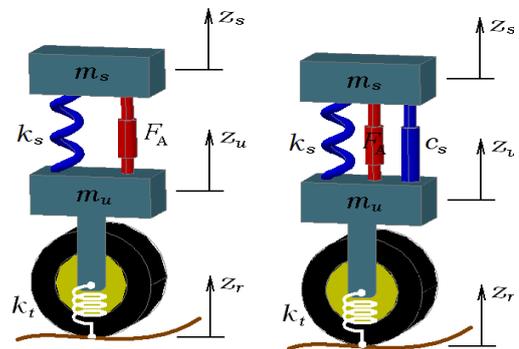


Fig.2 Suspension System

Concept Design/Concept Drawing

Illustrations at Fig. 5.a, 5.b, 5.c give out the proposed design concept of the Skyscraper Bus. Bus will be of 100 metres basic height with facility to add 50 meters incremental modules vertically depending on customization requirements of customer’s up to 400 meters. Bus structure assumed Rectangular type with area of 20 meters x 10 meters. This will be sufficient for existing roads of Megacities.

Body Materials

The materials used in the frame can be: 3CR12; 304 Stainless Steel; galvanized steel or 6000 series Aluminum alloy. New generation materials like Titanium, Carbon Fibers and composites may also be suitable.

Other Systems

These systems shall include the following

- Cooling System
- Exhaust System
- Electricals System
- Passenger Door (2 Door On each floor)
- Rear Vision mirror
- Interior lighting
- Exterior lighting
- Heating and Ventilations
- Roof Vents
- Security Video Camera
- Corrosion Protection
- Spare Parts(ex-stock)
- Provision for Passengers with Disabilities

Current Development Stage of Buses



Fig.34 Floor Skyscraper Bus



Fig.4 5 Floor Skyscraper Bus

Proposed Design Concept of Skyscraper Bus (MultiFloor) which will Optimize Traffic System of Buzing Megacities

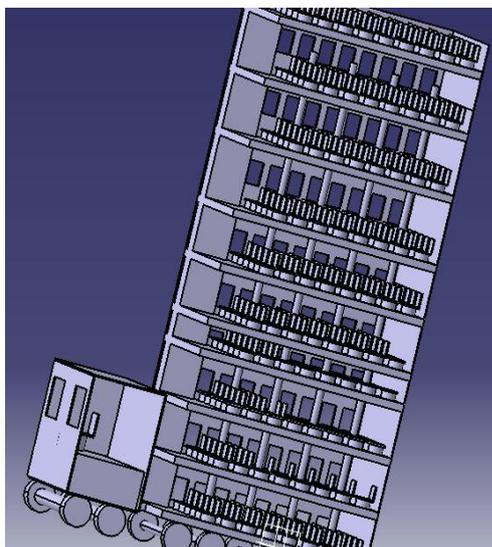


Fig.5.a Multi-Floor Skyscraper Bus

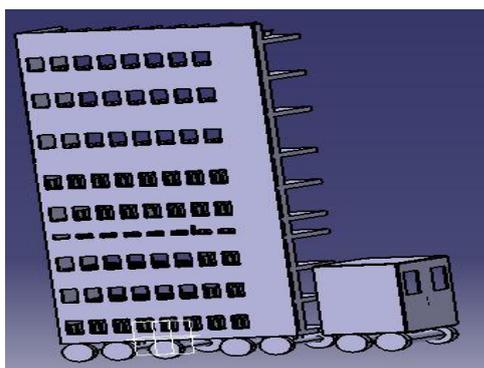


Fig 5.b Multi-Floor Skyscraper Bus

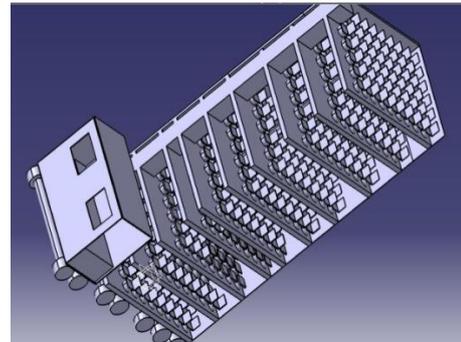


Fig.5.c Multi-Floor Skyscraper Bus

Analysis of Forces & Requirement of Stability of Skyscraper Bus under following Scenario:

- Scenario 1** (When Tall Bus is on level ground/almost level ground and static)
 - Scenario 2** (When Tall Bus is moving in forward direction on level ground/almost level ground.)
 - Scenario 3** (When Tall Bus is moving in reverse direction on level ground/almost level ground)
 - Scenario 4** (When Tall Bus is moving in forward direction on an ascending incline like flyover etc.)
 - Scenario 5** (When Tall Bus is moving in forward direction on a descending incline like flyover etc.)
 - Scenario 6** (When Tall Bus is moving in reverse direction on an ascending incline like flyover etc.)
 - Scenario 7** (When Tall Bus is moving in reverse direction on a descending incline like flyover etc.)
- An Analysis of the above scenarios is being analyzed and will be discussed in future paper

Trouble shooting/Breakdowns

Providing Engineering support and maintenance to this huge Skyscraper Bus is going to be an Engineering challenge. But the problems are not insurmountable. These can be easily solved with some engineering solutions.

Force analysis on bus and rolling factors and engine specification

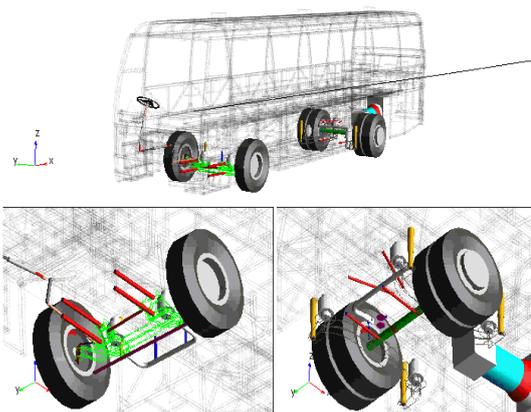


Fig.6 a Load distribution on each wheel

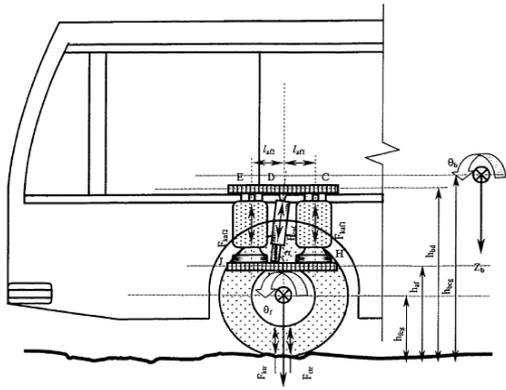


Fig.6.b Load distribution on each wheel

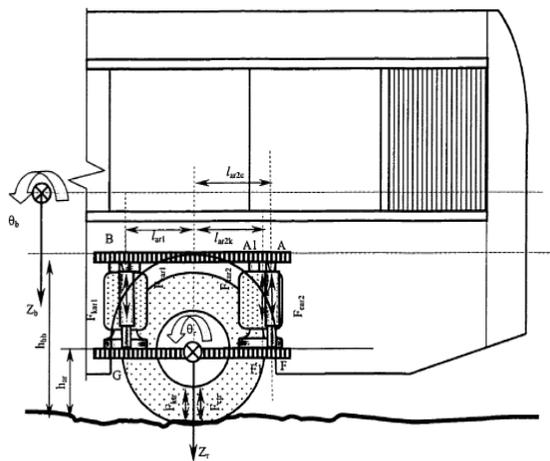
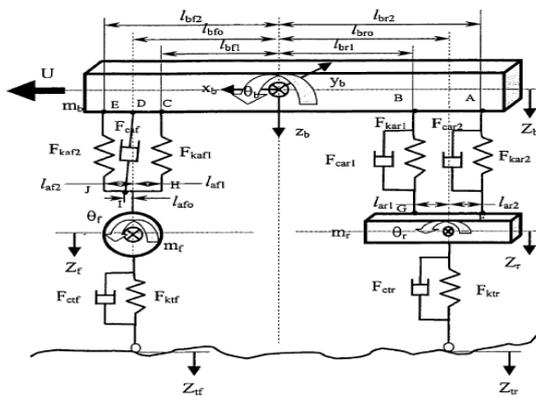


Fig.6. c Load distribution on each wheel



Static Force Analysis

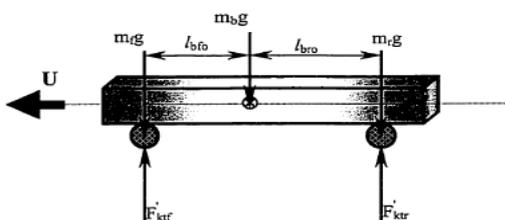


Fig.6.d Engine Steering Stability

Kinematics of rolling

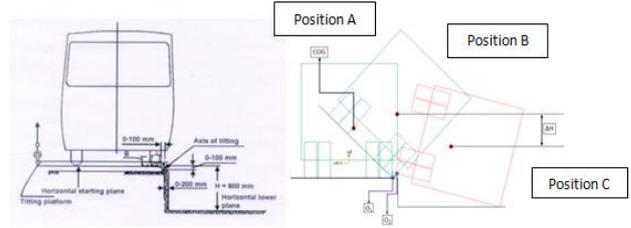


Fig.6.e Kinematics of rolling

$$1/2 I_{RA} \omega^2 = M * g * \Delta H$$

Where,

$I_{RA} = I_{COG_XX} + Mass * D^2$ (Mass moment of inertia about rotational axis)

ΔH = Height between Max. CoG & Final CoG

D = Distance between CoG and Second point of rotation

O_2

ω = Angular Velocity

M = Total mass of the bus

g = Acceleration due to gravity.

Factors which influence the rolling because of its giant size

- Position of CoG

Stability of bus while turning is dependent on the position of CoG of bus. If height of bus CoG is more, the bus will be more prone to rollover than one having low CoG. Also as height of CoG increases, the radius of rotation will increase, which increases the kinetic energy in structure before impact resulting more damage to superstructure.

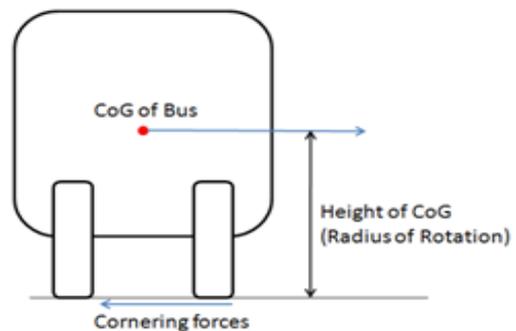


Fig.6.f C.G Force

Hence, during design proper caution would be catered for ensuring minimum CoG of the Bus

- Number and Position of pillars

As the structural pillars absorb energy during roll over impact, it is necessary to optimize the no of pillars. More no of pillars will add unnecessary weight and less no of pillars will fail in roll over simulation.

- Tubes Cross Section

The strength of the structure is mostly depending on the cross section of the tubes used in the structure. If the bus is failing in rollover analysis, the strength of the structure can be increased by increasing cross section (Breadth, width or thickness) of crucial members in rollover analysis.

- Material Properties

The stronger the material, the stronger the bus is against roll over. Material should absorb more energy of impact by deforming rather than failing. Aluminum can be used for stretch panels which weigh less and absorb more energy. However, depending on budget and city safety regulations/ tradeoffs the materials will be selected.

Limitations

The Skyscraper Bus will be a viable concept. However following limitations are expected

- (a) Dedicated bus corridor/ tracks will need to be planned in cities for this type of bus.
- (b) Amalgamation of various engineering system will require tremendous synergy.
- (c) Elevated Roads/ flyovers will have to be repositioned for the Bus.
- (d) Speed limitation may be a hindrance during peak hours of traffic. Optimum speed may not be more than 40 Km/hr.

Conclusion

The above Paper in brief brings out the compelling need to revisit the present models of mass Transportation. And brought out the saturation limit of current technologies/methods. An innovative way has been presented to transport people enmasses to their respective places. And other places in future footprint liability on the planet earth. The concept will be also proving economical for various cities like Mumbai, Bangkok, as well as London, New York and Moscow.

The concept brought out in the paper is an attempt to present the limitation of current transportation models.

The paper presents the facts that with the megacities rising and rising across all continents the same possess an environmental threat to the planet. At the same time it also presents viable models of mass people movers which will carry people not in hundreds, but possibly thousands of people.

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