



Advantages of Multi-system Monorail System in Logistics Transportation

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A large teal diamond graphic is positioned on the left side of the slide, serving as a background for the 'CONTENTS' text.

CONTENTS

1 Multi-system monorail and its characteristics

2 Evaluation of social benefits and development prospects

3 R & D team

4 Case study: Multi-system monorail logistics system

5 Conclusions



1 Multi-system monorail and its characteristics



Monorail System:



The Multi-system Monorail System



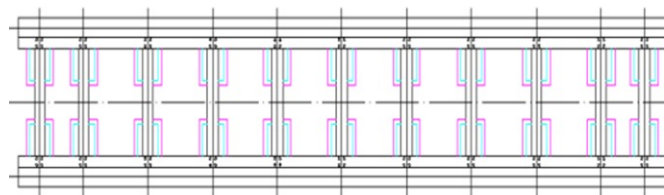
**The first generation flexible
suspended monorail system**



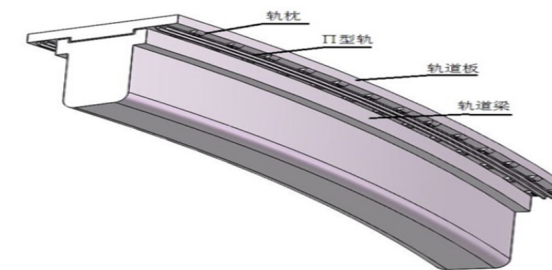
**The second generation half-rigid half-
flexible suspended monorail system**



**The third generation rigid
suspended monorail system**



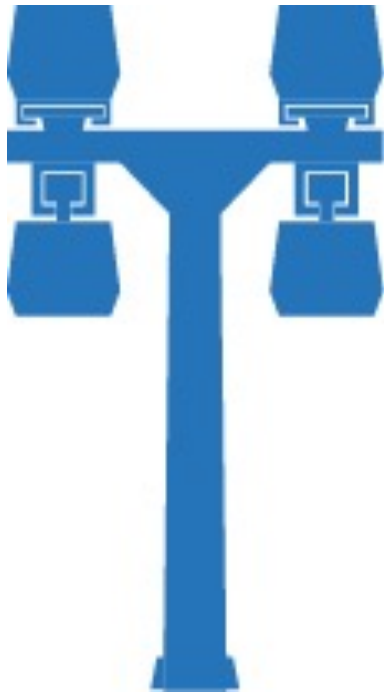
**The first generation jointed
track maglev system**



**The second generation seamless
line maglev system**



At present, the interpretation of the concept of Multi-system is mainly based on the division of vehicle system, which can be roughly divided into seven categories: subway, light rail, monorail, tram, maglev, AGT and rapid rail transit. The development of Multi-system is the integration of various common systems mentioned above.



Multi-system monorail system is based on monorail transit technology (including suspended monorail, straddle monorail and maglev), which is set up on the road slope or the central divider and makes intensive use of the resources of low-altitude passage inside the city or expressway.



Technological achievements



On November 19, 2020, the *Design Code for Multi-system Monorail Transit* was approved as group standard by China Communications and Transport Association. This code is the only one in the world that involves Multi-system monorail transit!

中国交通运输协会文件

中交协秘字〔2020〕52号

中国交通运输协会关于《多制式单轨交通设计规范》等团体标准立项的公告

各会员单位、有关单位：

依据《中国交通运输协会团体标准管理办法》相关规定，经中国交通运输协会组织专家评审，《多制式单轨交通设计规范》等17项团体标准（见附件）符合立项条件，批准立项，现予公告。

请各相关单位按照 GB/T 1.1-2020《标准化工作导则 第1部分：标准化文件的结构和起草规则》要求，做好标准制订工作，确保质量，增强标准规范性、适用性。欢迎单位或个人参与上述标准项目有关工作。

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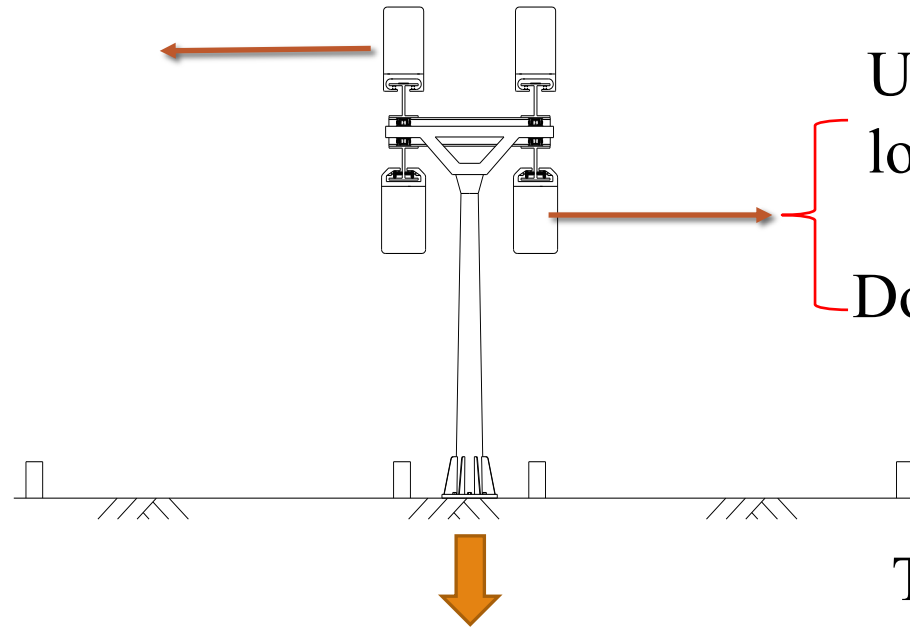


Upper maglev and lower suspended structure



Upper maglev, lower suspended transportation system

The system can be built on the central green belt of existing expressways, or in urban streets and other places with serious traffic congestion to relieve urban traffic pressure.



Central road divider

Upper maglev,
lower suspended

Double standard four channels

The overall system does not occupy the road surface and occupies very little space.



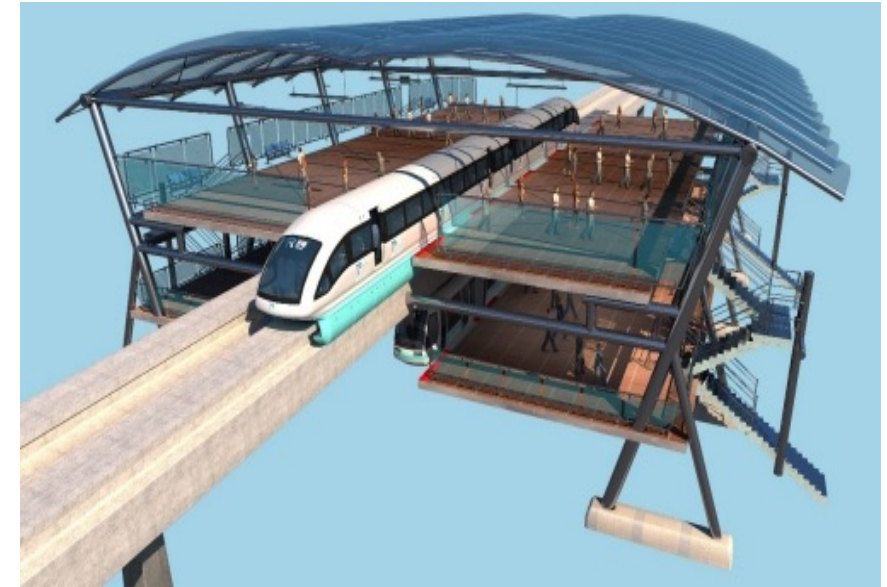
- ❑ Establish multi-system rail transit named *Tian Gui* transportation system, integrate monorail development mode, realize efficient and fast transportation system upgrade
- ❑ Passenger and cargo integrated transportation, multi - standard integration development
- ❑ The piers and columns of the project can adopt prefabricated reinforced concrete structure and prefabricated concrete filled steel tube structure, which has strong realizability and operability



Multi-system system



Multi-system monorail transit Also known as Tian Gui is a new monorail system developed by Professor Zhu of Beijing Jiaotong University with completely independent intellectual property rights. A complete theoretical system and core patent support group are constructed from the aspects of guideway, pier column, station yard, vehicle bogie and turnout. This technology will lead the development of innovation economy as a new economic growth point.

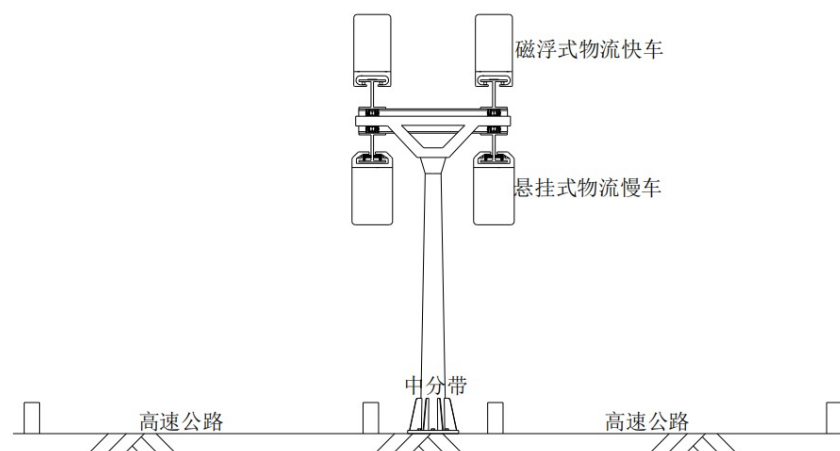


Multi-system system station



Innovations :

- ❑ The new mode of Multi-system structure of one guide way and multiple system, integration of the existing monorail concept
- ❑ Multi - standard combined transport, higher rail transport efficiency
- ❑ The original new rail transit assembly system leads the new development of the industry





Characteristics of Multi-system monorail

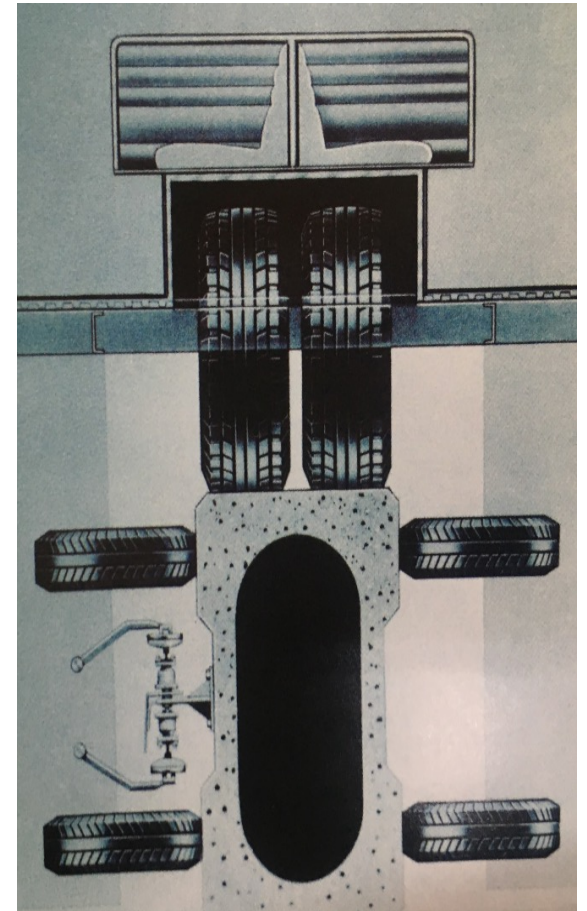


(1) Safe

The traveling mechanism is totally different from that of the steel-wheeled rail system in railways or subways.

The bogies of the vehicles are all rail-holding structures. There will be no derailment accidents, which fully guarantees the operational safety of the system.

In addition, the Multi-system logistics system runs in the air and has a fixed track, so there will be no collisions with other external trains.



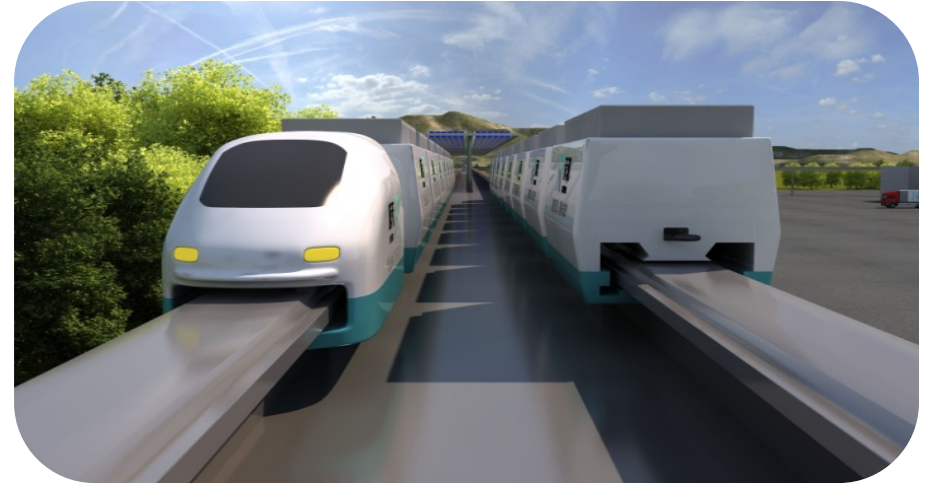


Characteristics of Multi-system monorail



(2) Environmental friendly

The Multi-system logistics system is powered directly by a catenary and driven by a motor, unlike the truck with exhaust emissions, so it is green and environmentally friendly.





Characteristics of Multi-system monorail



(3) Simple construction

The integrated system adopt the prefabricated structure form, which can be produced in advance in the factory, and then transported to the site for installation. It greatly saves the time of site construction. The reinforced concrete bored cast-in-place pile is adopted for the foundation of pier column.





Characteristics of Multi-system monorail



(4) Automation and flexible

- The maglev train or straddle monorail train and suspended monorail train in the Multi-system logistics system all adopt the whole automatic driverless system.
- According to the needs of road and urban development, the Multi-system logistics system can be extended or disassembled at any time and can be moved to other places to be installed and used again without too much waste of resources.





Characteristics of Multi-system monorail



(5) Other characteristics

Low civil cost and No need for land acquisition and demolition

- Very small land use and little demolition work needed
- The maglev in the system can reach 600 km/h
- The combination of fast and slow channels can be used to assign priority levels to goods for transportation



A large circular graphic with a teal border. The top half shows a high-speed train traveling through a green landscape under a blue sky. The bottom half shows a close-up of the train's tracks and the side of the train.

2 Evaluation of social benefits and development prospects

2 Evaluation of social benefits and development prospects



Hidden danger of subway-storm and rain

On July 20, 2021, a rare and extremely heavy rain fell in Zhengzhou, China, causing serious water accumulation in the Wulongkou parking lot of Zhengzhou Metro Line 5 and its surrounding areas. The stagnant water smashed the retaining wall of the entry line and entered the main line section, causing a train of Zhengzhou Metro Line 5 to stop in the section between Shakou Road Station and Haitansi Station, and more than 500 passengers were trapped. Unfortunately, 12 passengers were killed and 5 passengers were injured and sent to the hospital for rescue.



2 Evaluation of social benefits and development prospects



On August 19, 2020, the largest flood in the Yangtze River in 40 years passed through the main city of Chongqing, China. The Ciqikou District and Chaotianmen District were flooded, and the entire public transportation was paralyzed. Only the monorail traffic on the viaduct was operating normally. It can be seen from the photos that there are only running ships and monorails on the viaduct on the Yangtze River! The elevated monorail is like a long dragon, driving in the flood on the Yangtze River.

The peak of the Yangtze River crosses the border, and the monorail is calm

2 Evaluation of social benefits and development prospects



Multi-system monorail transportation system applicable to the five areas

At present, the Multi-system monorail transportation of large, medium and small cities, urban-rural integration areas, tourist attractions, urban capillary traffic areas, and cultural tourism characteristic towns is completely blank, and there is an urgent need for fast transportation methods to promote their development:

1. Large, medium and small cities
2. Urban-rural integration zone
3. Tourist attractions
4. Urban capillary traffic area
5. Cultural tourism characteristic town



Adaptation areas: According to statistics, there are 3,185 cities and counties in China that adapt to Multi-system monorail transportation. Among them, there are 334 prefecture-level cities, 2851 county-level cities, and tens of thousands of tourist attractions at home and abroad.

A large circular image with a teal border showing a high-speed train traveling through a green landscape under a blue sky with clouds. The train is white with a blue stripe. The image is partially obscured by a blue banner with red text.

3 R & D team



Introduction



Eryu Zhu, Ph.D, postdoctoral, professor, doctoral supervisor, vice president of the International Monorail Association (IMA). He is now the director of Research and Development Center of Straddle Monorail Transit in School of Civil Engineering of Beijing Jiaotong University. He mainly engaged in the research of straddle monorail, suspended monorail, maglev and other transportation fields. He has trained more than 100 doctoral and graduate students.





The team consists of many professors, more than 20 doctoral students and more than 50 master students. The team is mainly committed to the technical innovation and promotion and application of monorail transit. It innovates and proposes leading monorail technologies such as the second generation rigid frame monorail system, the third generation rigid suspended monorail system, the second generation seamless maglev system, and the Multi-system monorail system.

跨座式单轨交通研发中心



**Research & Development Center
for Straddle Monorail Transportation**

北京交通大学土木建筑工程学院

A large circular frame with a teal border contains a 3D architectural rendering of a monorail system. The top half shows a white monorail train traveling on a track through a green field under a blue sky with clouds. The bottom half shows a perspective view of the monorail tracks and a concrete support structure.

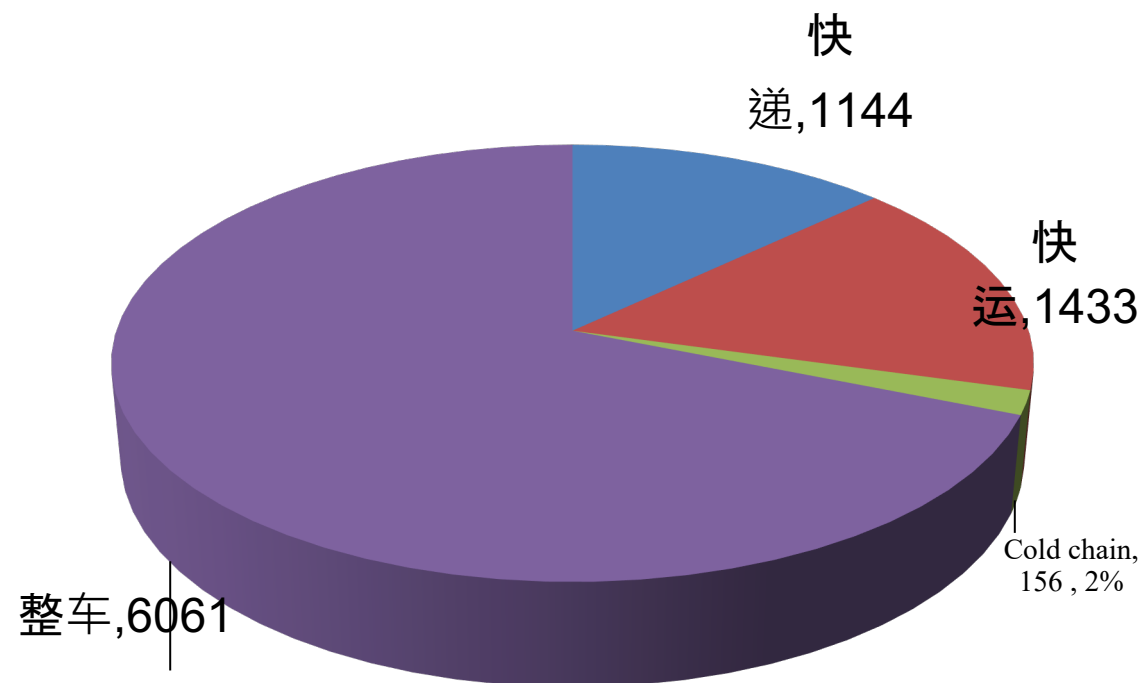
4 Case Study: Multi-system monorail logistics system



(1) Beijing-Tianjin highway cargo volume in 2017



- The Beijing-Tianjin expressway is the second direct highway between Beijing and Tianjin.
- The main road is designed for eight lanes in both directions.
- The Beijing-Tianjin expressway has a total length of 140km, and the terrain of the whole line is flat.
- It is known that the cargo volume of the Beijing-Tianjin Expressway in 2017 was 87.95 million tons.

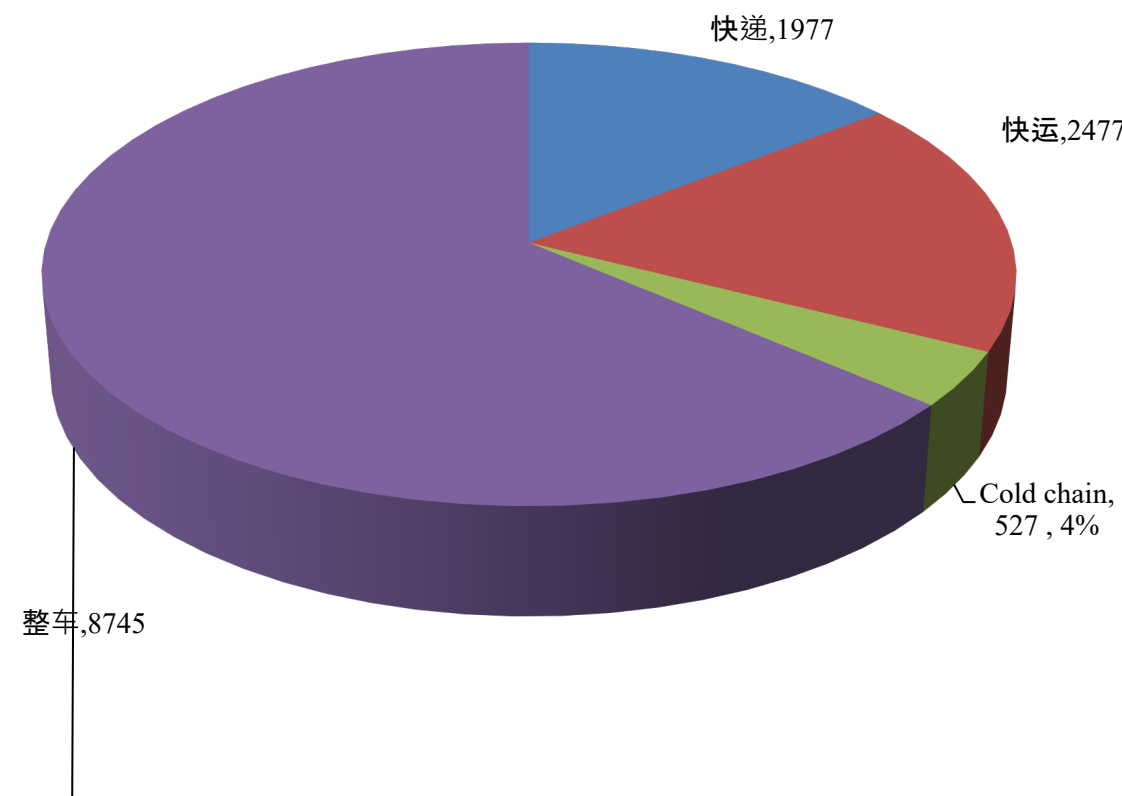




(1) Beijing-Tianjin highway cargo volume in 2020



It is estimated that the annual growth rate of express delivery and fast freight in China are both 20%, and that of cold chain is 50%.





(2) Multi-system logistics line on the Beijing -Tianjin highway



- It is assumed that the Multi-system logistics transportation line is built on the Beijing-Tianjin expressway.
- The length of the line is 140km and there are four two-way channels running. Trains leave from opposite directions every five minutes.
- The upper layer is maglev type, 8 ~ 10 sections a group, each section 0.5 ~ 0.75t, each trainload 4.0 ~ 7.5t, and the charge is 0.6 yuan per ton kilometer.
- The lower layer is suspended type, 8 ~ 10 sections a group, each section 1.0 ~ 1.5t, each trainload 8.0 ~ 15.0t, 0.3 yuan per ton kilometer charge.



(2) Multi-system logistics line on the Beijing -Tianjin highway



The construction cost is about 30 million yuan per kilometer, and the project investment payback period is calculated as follows:

The static payback period is: $500000 / (12614.6 + 18921.6) = 15.85$ years.



(2) Multi-system logistics line on the Beijing -Tianjin highway



Table 4 Static payback period and internal rate of return at different price of Multi-system logistics system

Annual price increase 5%	0.6 yuan/ ton-km	0.3yuan/ ton-km	maglev 0.6yuan/ ton-km suspended 0.3Yuan/ ton-km
Payback period	13.21	17.62	15.85
15-year internal rate of return during operation	6.04%	2.36%	3.66%
20-year internal rate of return during operation	8.96%	5.79%	6.91%

A large circular image with a teal border showing a high-speed train traveling on a track through a green landscape under a blue sky. The train is white with a blue stripe. The track curves to the left in the distance. The bottom half of the circle shows a close-up of the train's side and the track.

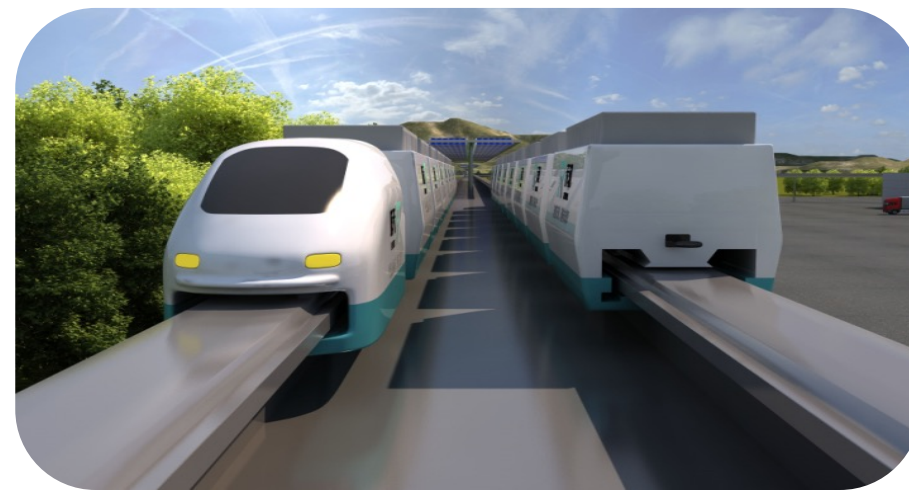
5 Conclusions



Conclusion



- (1) The integrated development of Multi-system system is the general trend of urban rail transit industry
- (2) The integrated passenger and freight transportation mode will refresh the new mode of urban rail transit, create a new name card of China's urban rail transit, and contribute to the development of China's technology export, talent training and related industries
- (3) The joint concept of Multi-system rail transit is in line with the trend of social development and will lead rail transit and other transportation industries





THANK YOU!

Prof. Zhu

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