



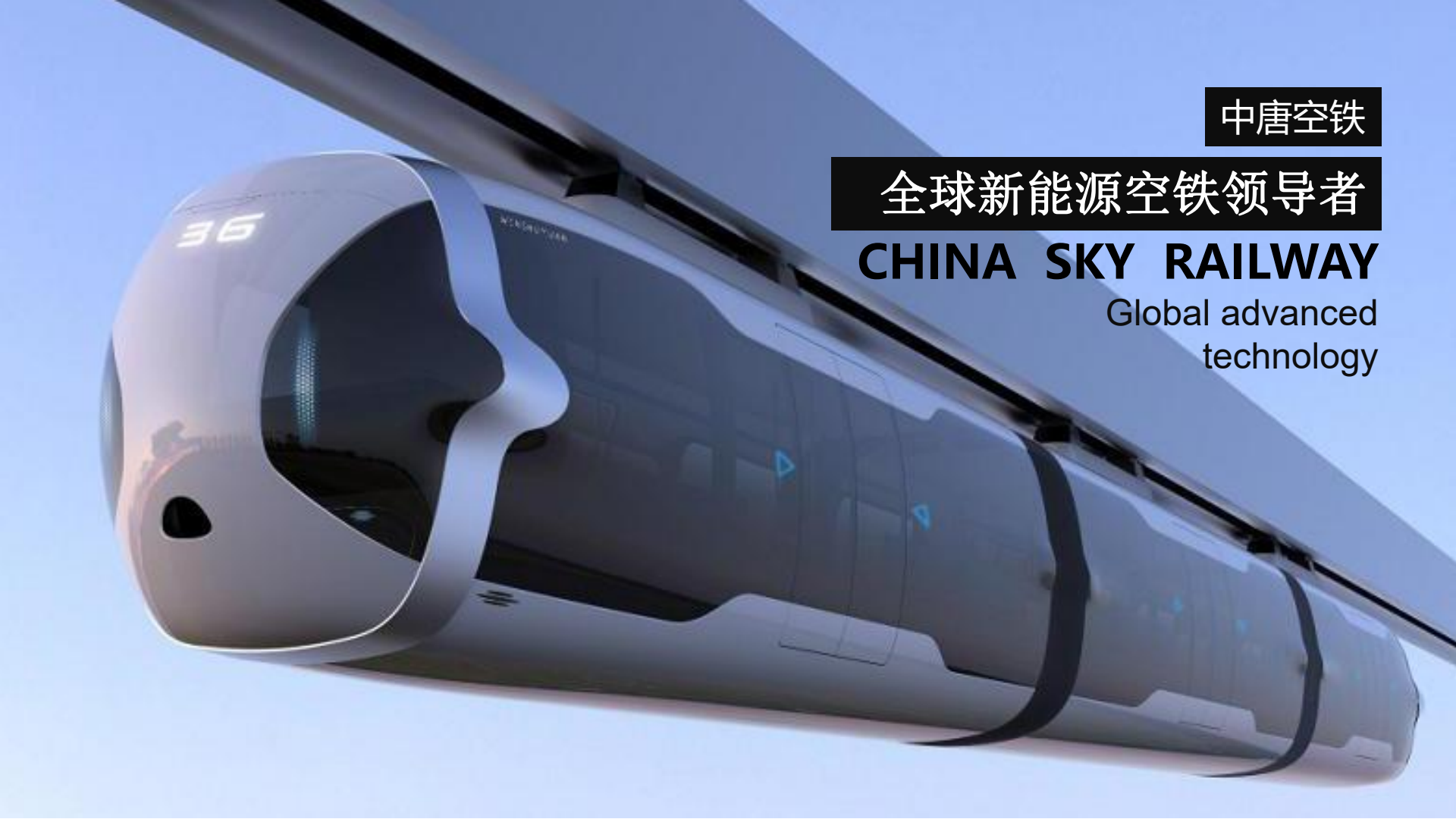
TM

CSR

中|唐|空|铁

# PRODUCT INTRODUCTION

► 产 | 品 | 简 | 介



中唐空铁

全球新能源空铁领导者

**CHINA SKY RAILWAY**

Global advanced  
technology

## 一、发展历程 DEVELOPMENT HISTORY

# DEVELOPMENT HISTORY

In 1893, suspended monorail traffic was invented by Eugen Langen in Germany. In 1898- 1901, 13.3km of suspension monorail railway was built in Germany, including 20 stations along the way. This is the earliest and oldest suspension monorail transportation in the world. It has been operating till now, and has no accident record in 98 years.



# DEVELOPMENT HISTORY

Recently, in Germany, Kuala Lumpur, Osaka, Sydney, Tokyo and some other cities, many amusement parks and airports have mounted monorail, and in Memphis, Dresden, Borussia Dortmund, Chiba and other cities also have this kind of means of transport.





## Zhongtang Sky Railway

proposed a new energy sky railway transport mode, which is powered by lithium battery power packs.

**2009**

research and  
development of  
battery technology  
and products

**2012**

technology  
development and  
market research of  
suspended sky  
railway

**2015**

the overall design,  
technology and  
market  
demonstration of  
the new energy sky  
railway system

**2016**

investment and  
construction of  
new energy  
suspended sky  
railway test line

**2017**

test demonstration,  
evaluation and  
standard  
formulation

## 研发团队

## DEVELOPMENT TEAM

**Datang energy investment group**  
more than 20 years experience in r&d, production and quality management of lithium battery

**China railway sixth survey and design institute group co. LTD**  
affiliated to CREC, the top Fortune 500 companies

**Nanjing puzhen vehicle co. LTD and Ziyang locomotive co. LTD of CRRC**  
China railway passenger transport and urban rail transit equipment professional development enterprises, integrated suppliers and solution providers

**Zhongtang sky railway group co. LTD.**  
the initiator and organizer of the new energy sky railway team

**Shanghai fuxin intelligent traffic control co. LTD.**  
mainly provides subway, rubber wheel system and other urban rail transit signal and communication system solution

**SWJTU (Southwest Jiaotong University)**  
the first national key laboratory of railway transportation in China

**Baoqiao group co. LTD. of CREC**  
railway ministry established as "research and development base for railway equipment"



专家团队

# EXPERT TEAM



**Tang Tong**  
overall program designer

chairman of  
Zhongtang sky  
railway group



**Zhai WanMing**  
chief designer

Academic Division  
s of the Chinese A  
cademy of Science  
s

professor of SWJTU

## 专家团队

## EXPERT TEAM

| Name                  | Title                           | Work unit   | Project board                                |
|-----------------------|---------------------------------|---|--|
| <b>Chu YongPing</b>   | professor level senior engineer | Nanjing puzhen vehicle co. LTD of CRRC                        | vehicle design                               |
| <b>Wang Kai</b>       | senior engineer                 | Zhongtang sky railway group                                   | project overall design, signal system design |
| <b>Peng ChangFu</b>   | professor level senior engineer | Ziyang locomotive co. LTD of CRRC                             | vehicle design                               |
| <b>Zhong Min</b>      | senior engineer                 | Nanjing puzhen vehicle co. LTD of CRRC                        | Vehicle bogie design                         |
| <b>Zhang XianFeng</b> | professor level senior engineer | China railway sixth survey and design institute group co. LTD | test line engineering design                 |
| <b>Fan JianGuo</b>    | professor level senior engineer | China railway sixth survey and design institute group co. LTD | test line engineering design                 |
| <b>Zhang Lin</b>      | professor level senior engineer | Baoqiao group co. LTD. of CREC                                | design and manufacture of track beam bridge  |

## 专家团队

## EXPERT TEAM

| Name                 | Title                           | Work unit   | Project board   |
|----------------------|---------------------------------|---|---|
| <b>Ji MinTing</b>    | professor level senior engineer | Baoqiao group co. LTD. of CREC                      | design and manufacture of track beam bridge             |
| <b>Chen LiJun</b>    | senior engineer                 | Shanghai fuxin intelligent traffic control co. LTD. | the overall design of the signal system                 |
| <b>Zhou DeChao</b>   | professor level senior engineer | Sichuan xintang new energy company                  | overall design of power lithium ion battery system      |
| <b>Meng XianPing</b> | senior engineer                 | Sichuan datang energy company                       | overall design of power lithium ion battery system      |
| <b>Wang KaiYun</b>   | professor                       | SWJTU   | project design  |
| <b>Cai ChengBiao</b> | professor                       | SWJTU   | project overall design, vehicle coupling dynamics model |
| <b>Wang HuaJun</b>   | senior engineer                 | Zhongtang sky railway group co, LTD                 | rail beam bridge  |

# SKY RAILWAY

**on 30th, September 2016, the  
first new energy sky railway  
line was officially suspended in  
chengdu, China**



**global leader in the field of suspended technology**

**eight technical advantages**

**keywords**

**technological green safe durable**





# TECHNICAL ADVANTAGES

## 1、independent research and development on suspension single track with power of lithium battery

iron phosphate lithium ion battery, extremely low internal resistance, stability, strong adaptability, work zones - 35 °C - + 55 °C。

the battery pack is placed inside the rail beam and separated from the train to avoid the associated risks

noise is low, 60 decibels within 6 meters, and 60 to 100 meters down to 35 decibels

energy saving and environment friendly, no high voltage transmission system, avoid electromagnetic pollution

closed track beam design, without fear of snow and rain, never unfaithful, overturning danger





# TECHNICAL ADVANTAGES

## 2、innovatively designed the suspension bogie of the compact rubber wheel system

designed without bolt bearing self-locking suspension mechanism with full independent intellectual property rights.

four connecting rod structure and secondary safety protection device with gap stop, which fully guarantees the safety of suspension.

adopt the one-piece drive axle structure with differential transmission, so that the empty vehicle has the minimal curve passing ability.

improve the noise and vibration of traditional steel wheel to ensure ride comfort.

advanced vehicle lightweight technology is designed with a hollow aluminum profile skeleton and a composite light weight vehicle.



# TECHNICAL ADVANTAGES

## 3、develop the whole translation system

use gear rack drive, through unlocking, panning, locking movement and realizing the straight stock of switch beam.

ateral stock moves in parallel and completes the switch

switch interface adopts the tooth - shaped joint structure to ensure the stationarity of the train



# TECHNICAL ADVANTAGES



## **4、signal control system based on ATO algorithm and BMS is designed**

signal control system adopts unique ATO intelligent dynamic multi-mode control algorithm and battery management system.

(BMS) real-time acquisition of parameters, dynamic adjustment of control algorithm, and maximization of battery power supply efficiency.

ac control system supports autonomous driving.

# TECHNICAL ADVANTAGES

**5、space coupling dynamics simulation analysis platform of the sky rail bridge is developed**



**6、advanced robot technology to realize automatic and quick battery replacement**





# TECHNICAL ADVANTAGES

## 7、the first new energy sky railway test line was established, and the relevant standards for new energy sky railway were established

after the project establishment by Sichuan provincial housing construction office, the standards are supplemented or modified to form local standards and enterprise standards, providing technical basis for subsequent demonstration and industrialization of projects



## new energy and air transport technology standards

- 《construction acceptance standard of the switch beam》《Interim provisions on the design of new energy and sky railway transportation》
- 《construction acceptance criteria for rail beams and pier》《Interim provisions on power lithium ion battery system for sky railway》
- 《estimate of the estimate of suspension monorail traffic engineering (trial)》《general technical conditions of suspended monorail vehicles (interim)》

# TECHNICAL ADVANTAGES

## 8、long service life of the system

more than 23,000 km of driving tests were carried out, and 84 battery performance tests and 180 vehicle performance tests were carried out

complete tests on axle coupling vibration, turnout reliability and maintainability, signal system ATO, ATP, ATS

design of bridge structure is for 100 years

vehicle design life is 30 years

life of solid rubber tyre is about 8 ~ 100,000km,  
and the guide wheel is about 150,000km

super lithium battery life: 8 years





# Zhongtang skyrailway has 26 core patents for new energy sky railway.

Organized by the science of Sichuan province is given priority to with 2 academicians of 15 top domestic rail transit experts achievements appraisal, evaluation of new energy sky railway as a new type of medium capacity of rail transit, the comprehensive advantages, the first at home and abroad, and fill in the new energy sky railway in the fields of rail transit, the overall technology has reached the international advanced level, among them, the large capacity lithium battery traction power supply technology, hanging empty tin vehicle lightweighting technology, empty trains - track girder bridge coupling dynamic simulation technology in the international leading level..



## 二、轨道类比 COMPARISON

Zhongtang new energy sky railway is the seventh kind of rail transit system after universal rail, high-speed rail, subway, light rail, tram and maglev train

**global first**



## rail transit system comparison

| mode/comparison                  | railway                    | high-speed railway         | metro                          | sky railway   | monorail   | tram                       | medium and low speed maglev |
|----------------------------------|----------------------------|----------------------------|--------------------------------|---|--|----------------------------|-----------------------------|
| feature of theline               | closing single road rights | closing single road rights | closing single road rights     | single road rights in the sky, column cross-section 0.8*0.8, pilespa cing 25m | single road rights in elevated road, short pilespacing, big column cross-section | open type(partial closure) | closing single road rights  |
| bridge and tunnel proportion     | large                      | large                      | Underground tunnel and viaduct | large   | large  | large                      | large                       |
| track gauge                      | 1435                       | 1435                       | 1435                           | monorail  | monorail   | 1435                       | 1435                        |
| minimum turning radius           | 400                        | 2000                       | 195                            | 30  | 100  | 30                         | 75                          |
| gradeability                     | 60                         | 30                         | 30                             | 104   | 60   | 60                         | 70                          |
| cost per kilometer (million RMB) | 70                         | 120                        | 500-1,000                      | 100-129   | 250-300  | 150-180                    | 300-450                     |
| failure rate                     | high                       | low                        | low                            | low   | low  | high                       | high                        |
| on-schedule rate                 | high                       | high                       | high                           | high  | high   | low                        | high                        |

## rail transit system comparison

| mode/comparison                      | railway   | high-speed railway                                    | metro   | sky railway           | monorail  | tram  | medium and low speed maglev                           |
|--------------------------------------|---|---|---|-----------------------|---|---|---|
| one-way capacity (thousand people/h) | 16  | 13  | 30-70   | 10-20                 | 8-40  | 5-10  | 15-30   |
| average velocity (km/h)              | 120   | 250-350   | 30-45   | 30-45                 | 30-45   | 15-30   | 30-45   |
| maximum velocity (km/h)              | 180   | 350-450   | 80-120  | 80-120                | 100-120   | 60  | 100-160   |
| noise factor (decibel)               | 100   | 80  | 85  | 65                    | 75  | 60  | 60  |
| kinetic energy                       | high tension electricity                              | high tension electricity                              | high tension electricity                              | new energy            | high tension electricity / new energy                 | super-capacitor                                       | high tension electricity                              |
| pollution                            | electromagnetic pollution and high pressure radiation | electromagnetic pollution and high pressure radiation | electromagnetic pollution and high pressure radiation | charging at the depot | electromagnetic pollution and high pressure radiation | electromagnetic pollution and high pressure radiation | electromagnetic pollution and high pressure radiation |
| comfort level                        | moderate  | high  | moderate  | high                  | high  | moderate  | high  |

## rail transit system comparison

| mode/comparison                 | railway  | high-speed railway                | metro                    | sky railway  | monorail                       | tram         | medium and low speed maglev |
|---------------------------------|--|-----------------------------------|--------------------------|--|--------------------------------|--------------|-----------------------------|
| control system                  | PTC train control system                               | CTCS-3 level train control system | BAS train control system | ATO algorithm and signal control system            | PLC intelligent control system | human driver | OCS                         |
| occupation of land              | large  | large                             | small                    | small  | large                          |              | large                       |
| migration amount                | large  | large                             | small                    | small  | moderate                       | small        | large                       |
| ability of adapting the terrain | moderate   | poor                              | poor                     | strong   | moderate                       | moderate     | good                        |
| ability of adapting to climate  | snow volume in the north has great influence on safety | good                              | strong                   | strong   | moderate                       | moderate     | moderate                    |
| landscape                       | moderate   | moderate                          | no landscape underground | 5 meters from the ground clearance, good landscape | good                           | moderate     | moderate                    |
| control system                  | PTC train control system                               | CTCS-3 level train control system | BAS train control system | ATO algorithm and signal control system            | PLC intelligent control system | human driver | OCS                         |



## rail transit system comparison

| mode/comparison                  | railway  | high-speed railway | metro  | sky railway           | monorail | tram                  | medium and low speed maglev |
|----------------------------------|----------|--------------------|--------|-----------------------|----------|-----------------------|-----------------------------|
| custom-made                      | cannot   | cannot             | cannot | can                   | cannot   | can                   | cannot                      |
| tourist productivization         | cannot   | cannot             | cannot | can                   | can      | can                   | cannot                      |
| investment scale                 | moderate | large              | large  | small                 | moderate | small                 | large                       |
| construction cycle               | moderate | long               | long   | short                 | moderate | short                 | long                        |
| disassemble                      | cannot   | cannot             | cannot | can                   | cannot   | cannot                | cannot                      |
| approval department              | NDRC     | NDRC               | NDRC   | provincial government | NDRC     | provincial government | NDRC                        |
| operational and maintenance cost | high     | high               | high   | low                   | moderate | moderate              | moderate                    |

## 空铁二十七 核心价值点 VALUE POINT

### product value

strong security   no pollution   zero emissions   fully automatic intelligent control   smooth and comfortable  
high speed   low noise   energy conservation and green

### applied value

no demolition   strong climbing ability   less occupation   strong weather resistance   short turning radius  
adapt to various topography   no digging holes

### cultural value

good landscape   cultural   lots of selling points   maximize resource utilization   can be customized

### maximize resource utilization

less investment   short construction   approval fast   quick returns   rapidly increasing regional value  
low maintenance cost   removable

### 三、空铁优势价值市场运用 THE PRODUCT APPLICATION



urban rail



travel track





# IN CITY

advantages in urban application of sky railway

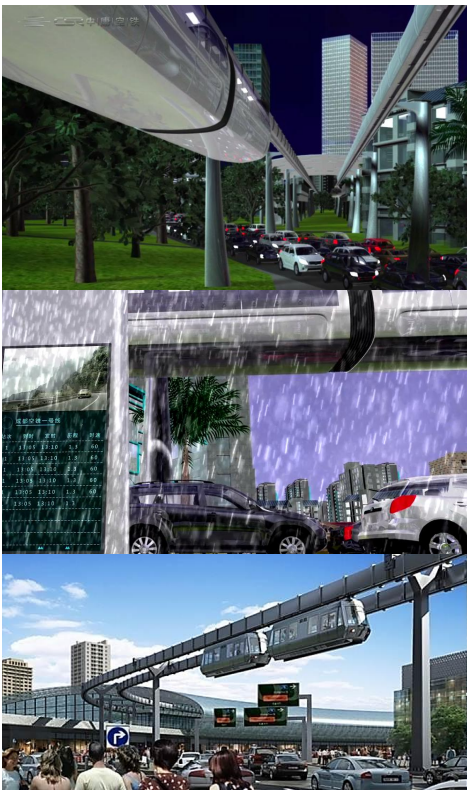
# SUPERIORITY

## 1、congestion

capacity of the sky railway can reach one-third to one-half of the total number of subway passengers, and the number of passengers can reach up to 500,000 people per day; minimum departure clearance is 120 seconds, the speed is equivalent to the subway, and the maximum range speed of 120km/h -- 150km/h is supported, efficiency is high.

elevated track, separate line, fast, on time.

can connect seamlessly with the urban traffic node, connect shopping mall, subway, station, etc., construct the three-dimensional transportation network, enhance the regional value, and form the interconnection between the regional circle and the urban and rural areas.





# SUPERIORITY

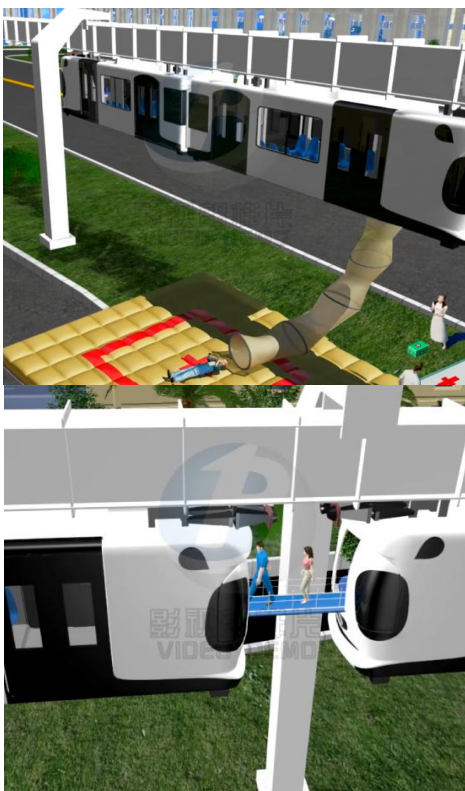
## 2、safe

closed track beam design, without fear of snow and rain, never unfaithful, overturning danger.

fire retardant materials are used in the interior of the vehicle. The power battery is free of explosion and low heating, and the battery is separated from the car body to minimize the fire risk.

scientific and complete rescue plan, active rescue emergency plan multi-directional linkage, response to various emergency situations.

intelligent control system, can not drive, long service life, reduce human operation risk.





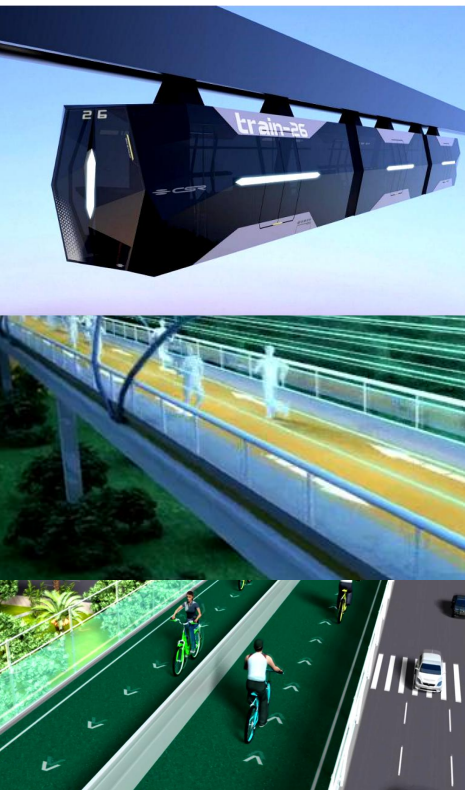
## SUPERIORITY

### 3、environment friendly

new energy battery pack power drive, without fear of power failure, no electromagnetic radiation, no emissions, no high voltage risk.

compact rubber wheel system suspension bogie, advanced vehicle lightweight technology, low noise, low vibration.

advanced robot technology, 90 seconds automatic quick change battery.



## SUPERIORITY

### 4、good image

track and vehicle can be customized according to different regional characteristics, promote urban culture, connect urban attractions, and enhance urban spatial image.

use the top of the track beam to erect the landscape corridor, set up the sky fitness trail, share the cycling lane, and increase the urban rail function.

# SUPERIORITY

## 5、less occupation

foundation of the track pier is bored pile, the base size is 80cm\*80cm, and the green belt of the city can complete the wiring, in the old city area where the road resources are tight, the city street lamp can be transformed into an orbital column, which does not take up the road, so it can be removed or removed.

short turning radius of the air train is small, and the limit area is only 30 meters, which can be used to make a detour without affecting the urban planning.

platform was set up in the sky, the bottom can be raised, the construction way diversification, according to the conditions of use in the middle of the road or on both sides of the erection, and seamless connection with the city building and transportation hub, maximize resource utilization.

the whole assembly structure of the vacant sky railway track can be disassembled or moved according to the urban planning, so as to avoid the waste of resources.





# SUPERIORITY

## 6、short construction

the new energy sky railway belongs to the medium and low volume urban rail transit, the provincial competent department can complete the approval, the approval process is fast.

construction and trial operation of 20 km line can be completed in 8 to 12 months, and the construction period is short.

small demolition, dust scattered, artificial blockage, construction has little impact.

from the plan deployment to the construction to the formal operation, the entire cycle can be completed within a year.

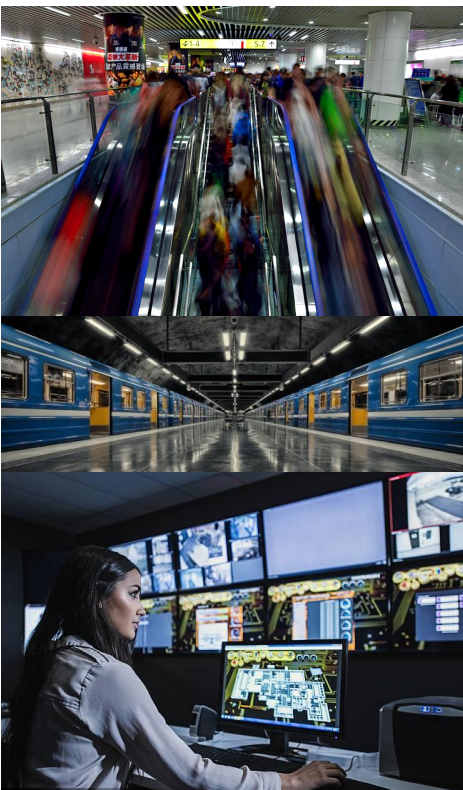
# SUPERIORITY

## 7、low cost

the cost of two-track line is RMB 100 million per kilometer, which is about 1/8 of the cost of the subway, and a quarter of the cost of light rail, the cost is low.

less area of expropriation, small influence to urban planning, and can be grafted with existing resources, and the derivation cost is low.

operation and maintenance cost is 2 million -- 2.5 million/km, the later cost is low.







# IN TOURISM

advantages in travel application of sky railway

# SUPERIORITY

## 1、Safe

in the peak tourist season, It is very difficult for huge number visitors to get in and out. By planning the layout of the sky railway line, it can quickly guide the crowd and effectively avoid group events.

firm structure, the whole body anti-corrosion, weather resistance is extremely strong, can resist 10 level wind, 9 earthquake, can be used as a rescue channel when necessary.

fully enclosed carriage, fully automatic deployment control, can also set up anti-riot level according to the requirements of the region, so as to avoid the occurrence of man-made malignant events.



# SUPERIORITY

## 2、strong climbing ability

capacity of climbing is 104‰, it is best in all track traffic modes.

because of its strong climbing ability, it can reduce the excavation and even the tunnel, save cost, and the bridge tunnel ratio is extremely low.

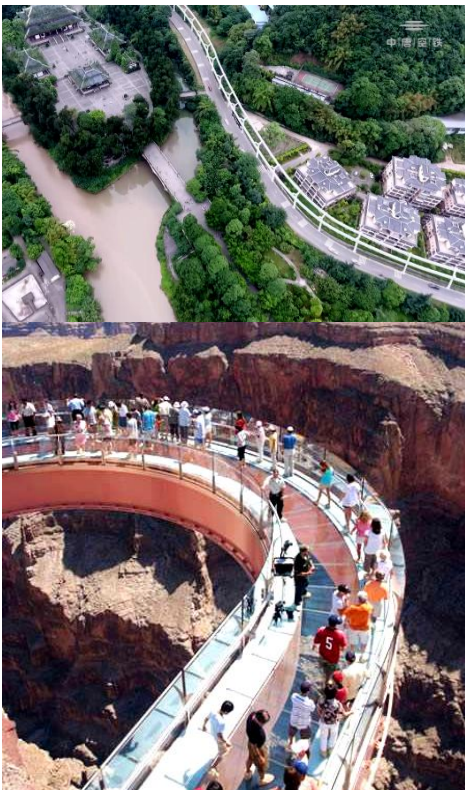


## SUPERIORITY

### 3、short running radius

smallest turning radius is 30 meters, can realize the mountain winding and canyon bending, terrain adaptability is extremely strong.

can be arranged along the existing road network to realize three-dimensional traffic, and can also go over mountains, rivers, lakes and villages, reduce the difficulty of scenic spot planning.





# SUPERIORITY

## 4、less damage

energy saving, environmental protection, zero emission, battery driven, enclosed car, pollution-free.

assembly construction, small amount of construction work, less tunnel Bridges, the maximum extent to reserve the natural features .

track can be removed according to the planning, saving resources without any hidden trouble.



## SUPERIORITY

### 5、good landscape

according to the characteristics of the scenic spot, the track can be covered by vegetation and the vehicle can be customized, which is in accordance with the scenic features.

in scenic spot the full glass train can be used, truly realize the omnidirectional landscape.

In the special topography areas, such as snow cover, mountain peaks, canyons, where vehicles and pedestrians is hard to reach, sky railway can be set up for the nice view.





# SUPERIORITY

## 6、 more selling points

take advantages of the sky railway, to enrich the content of tourism, increase the visiting time of scenic spots, improve the tourist income and increase the staying time of tourists.

the panoramic carriage of the sky railway can be used as a glass walkway in the sky. It will become a special spot in the scenic area.

customized tour products, for example: customized trains for marriage proposal , honeymoon, dinner and so on.

develop seasonal tourism products according to the seasonal landscape changes and the advantages of sky railway, narrow the gap between the slack season and peak season.



# SUPERIORITY

## 7、systematize

sky railway can connect scattered scenic spots to form a tourist circle, it can connect seamlessly with urban bus stations, high-speed trains, parking lots and other traffic hubs, one pass for all vehicles.

according to the characteristics of the scenic spots and the rail line, Zhongtang sky railway can integrate superior tourism resources to Improve the function of scenic spots.

through the extension and connection of the sky railway line, people can be introduced to poor areas or areas to be developed, and the industry can be driven, and the regional heat can be rapidly increased.





# IN CLIMATE

Extreme weather adaptation



## SUPERIORITY

### 1、Anti-wind capability

The sky railway can operate safely in a wind force of 10 ( wind speed:105km/h). In extremely special circumstances, for example, during the landfall of a strong typhoon, the wind in the range 11-12, the sky railway can ensure enter the station safely.

According to the compulsory public transportation regulations of various provinces and cities, traffic is suspended during the ten-stage wind warning. The new-energy sky railway meets the relevant national standards in terms of wind resistance.

**Flood resistance is designed at 1/100 frequency. Excellent wind and water resistance capabilities will ensure the safe use of sky railway in all coastal areas of China in extreme weather conditions.**





# SUPERIORITY

## 2、Seismic Capacity

The highest seismic fortification level of the sky railway is magnitude 9, with the intensity magnitude 9 and below, the train can ensure safe operation.

The ability of the suspension girder bridge to resist mountain flood, debris flow, landslide and other common geological disasters is particularly outstanding. The geological disasters with impact height of less than 5 meters have no material effect on the operation of sky railway.

**Excellent seismic and disaster resistance capability can ensure the safety application of sky railway in extreme conditions in most mountainous areas of China.**



## SUPERIORITY

### 3、Cold Resistance

The lithium batteries in the power system can withstand temperatures between -45 and +60 degrees Celsius, which can meet the temperature conditions in all regions of China.

The power system are all enclosed within the track box girder, and the electric heating system is assisted to ensure the safe operation in snow and ice weather.

**Excellent system design against snow and ice, extreme cold and extreme heat can ensure the safe application of sky railway in all temperature zones in China.**



## Zhongtang sky railway

preferred solution for the branch line connection of large urban rail system  
main solution of small and medium-sized urban rail transit  
best solution to the travel area track



videos of sky railway ▶

#### 四、空铁合作模式 COOPERATION



1

**purchase**



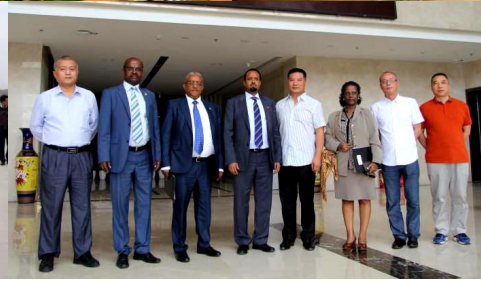
2

**investment**



3

**joint  
development**





1

## **purchase**

### **PPP**

the government led the development, the government platform company and the sky railway company collaborate

### **EPC**

Owner's direct purchase, the sky railway company is the general contractor for the line, complete suspension of the sky railway, normal operation

### **financial lease**

the owner pledges the property right of the line to the financial institution to obtain funds to complete purchase and redeem it at maturity, as the general contractor of the line, the sky railway company completes the construction to the normal operation

### **financing and agency construction**

The sky railway company provides financing services to owners, and the full range of equipment to the normal operation of the line



2

## investment

### **BOT+TOD**

to realize the integration of operation, construction, and investment by BOT, to cover the investment and operation cost through the comprehensive development of the property along the track

### **BOT+investment subsidy**

the financing gap other than operating income is subsidized or replaced by the owner

3

## joint development

### **asset securitization**

jointly set up an IPO entity company, Joint listing to achieve revenue

### **equity cooperation**

evaluate and measure the value of the sky railway line and the scenic spot, Joint establishment of management and operation system, manage together



► 全球悬挂式轨道交通行业领导者 ◀

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