

ould receive an award? How does it demonstrate:  
Professional excellence

- . transparency and integrity in the management and project implementation
- . sustainability and respect for the environment

Wuhan – a richly historied city, is divided by Yangtze River – the third longest river in the world. The city becomes prosperous due to the river but also has very inconvenient traffic conditions arising from the obstruction of the river. Wuhan Urban Rail Transit Line 2 Project is built for the purpose of solving the traffic problem crossing the Yangtze River, with a total length of 27.735 km and designed with 21 stations in total. It is the first fully-underground rail transit line in Wuhan City and the first subway line crossing Yangtze River in China, and furthermore, a key rail transit line with the maximum passenger flow as predicted in the URT network. This line has connected several important nodes in Wuhan City and is hailed as a golden URT line in Wuhan City.

The study work of this project was commenced from 1996 and it was opened to traffic for trial operation on December 28, 2012. It primarily solves the river-crossing problem in Wuhan City, alleviates the traffic pressure on Wuhan Yangtze River Bridge and The Second Wuhan Yangtze River Bridge and assumes 50% of river-crossing passenger flow realized by public transit system.

#### **I. Arduous and Complicated Work, Leading Innovation Achievements**

Wuhan URT Line 2 Project is a huge systematic endeavor that involves with more than 30 specialties. Its significant functional orientation and particular engineering geological & hydrological conditions present a huge challenge to the engineering construction in the history of subway construction all over the world. For that reason, a batch of innovation achievements has been obtained as well:

1. The most outstanding characteristic of this line is to run through the Yangtze River. The river-crossing work is realized by shield method. To satisfy the requirements for disaster prevention and ventilation necessary for the operation safety, it is designed to build two air shafts at intervals of 1,600 m nearby the embankments at both banks of the Yangtze River, to solve and track the ventilation and dust exhaust of operating trains in case of fire disaster. The air shaft built at the bank in Wuchang is up to 46 m deep, which creates a new record in depth of foundation pits in the urban construction history of Wuhan City. To realize the interconnection among subway tunnels and provide an evacuation passage for passengers in case of disaster, it is designed to use frozen earth below the river bed for protection and build two interconnected passages, and it is the first to build interconnected underwater passage in sandy strata in the middle and lower reaches of the Yangtze River.

Meanwhile, the construction of tunnel passing underneath the Yangtze River also creates several new records such as 3, 100 m length of nonstop tunneling and resistance to 5.5 bar water pressure etc.

2. This line is consistent with the humanistic and environmental protection. This line passes through the entire main urban area of Wuhan City, passes underneath the busy Beijing ~ Guangzhou Railway and Hankou Railway Station, and runs through the flourishing but narrow Walking Street of Jiangnan Road as well as a great many of important buildings. We always

development between engineering construction and project demonstration and approval nearly took 10 years.

With regard to preliminary works, we had solicited opinions from the public and the stakeholders in all aspects, to maintain and respect the cityscape as practical as possible.

3. This line realizes convenient transfer and facilitates the public's travel. It uses the experience in transfer of Hong Kong and Stockholm subways for reference and builds Hongshan Square Station and Zhongnan Road Station on Lines 2 and 4 as per the style enabling continuous transfer on same platform, which is the first to use in China mainland, for the purpose of improving the transfer convenience to the greatest extent and thus facilitating the public's travel.

4. This line entirely adopts the general-purpose wedge ring shield segments of the same size to build the subway for the first time in China. Reasonable allocation of shield segments plays an important role in the engineering construction.

5. The subway design gives consideration to the development as well. Based on the ideas of resource sharing and intensive development in the car depot of Changqing Huayuan and the parking lot of Zhongshan North Road, the development and design plan for superstructures built within and surrounding the rolling-stock base depot has established a new path for design of the rolling stock base.

6. Parking lot of Zhongshan North Road adopts the design technique for automatic parking lot and incorporates the yard signal into ATC system for the main track, so as to enable ATO driving mode to be consistent with the main track in the parking lot. The technique for automatic parking lot stands for the most advanced level in China.

7. PIS system adopts DVB-T digital television technique independently researched by FiberHome Technologies, to realize train-ground PIS signal transmission at 1.8 Ghz signal band and completely avoid the mutual interference between the types commonly used in China with CBTC2.4Ghz signal at the same frequency band, with great bandwidth and strong anti-interference capacity, originated in China.

8. Wireless fire fighting signal is firstly introduced to the entire space of subway in China, to satisfy the requirements for underground disaster relief and communication.

9. AFC system is the first in China to use two-way gates along the entire line in China, so as to improve the convenience of operation management, decrease the category of devices, facilitate the maintenance management and lower down the category of spare parts.

10. Metro vehicles make use of long LCD screen for dynamic routing map for the first time in China. It is the first to realize the real-time two-way fully functional video transmission and multimedia broadcasting in China.

## II. High Quality and Brilliant Professional Level

1. The overall design is carried out in strict accordance with the key design philosophies, i.e. firstly in view of high speed urban sprawl in China, the scale is such designed to reserve for further urban development and population growth and station buildings are designed as per size of 6B vehicles during the early phase and reserved for 8B size; secondly, the development is done as per the mode of "subway + property", among which the earnings from subway property will be used for subway construction and operation maintenance, to ensure the sustainable development of subway works in Wuhan City, while property design conducted

one million m<sup>2</sup>, and; thirdly, humanized and cultural design is conducted in view of station facilities, fitment, guiding and accessibility etc. Automatic book lending system, drinking water system, special waiting area for the female etc. equipped in the stations take a leading position in China.

2. The successful construction of tunnel crossing the Yangtze River proves the high level of existing tunneling technique in China. This line has created several "No. 1 in China", i.e. firstly, the one-way tunneling length by shield machine exceeds 3,100 m, setting a new record in China; secondly, the thin-wall shield segment structure of  $\varnothing 6,000$  mm & 300 mm thickness is adopted to bear the water pressure up to 5.5 bar; thirdly, the auxiliary tunnel construction technique through freezing method is used and two intermediate passages to connect through the main track tunnels have been successfully built below the river bed of Yangtze River, to realize an important breakthrough in construction of similar works in sandy stratum in the middle and lower reaches of the Yangtze River, and; fourthly, the air shaft at Wuchang side of the river-crossing tunnel is 46 m deep and 100 m from the Yangtze River embankment, the unique joint technique designed for double-wheel trench cutter construction of the diaphragm wall structure for construction of air shaft is used, to successfully cope with the limitless challenge from flood control in the Yangtze River.

3. This line runs through various sections with complicated geological conditions. During the construction, problems such as deep soft soil in the first terrace of the Yangtze River that may easily lead to settlement deformation, burst of high-confined water in foundation pit and construction safety in gas stratum through shield method etc., as well as strata in ancient river course of the Yangtze River within third terrace, karsts, red beds of expansive soil and karst, are encountered. Along this line, engineering geological conditions are complicated and variable and the construction risk is high.

4. All cities alongside the Yangtze River normally have very complicated engineering geological conditions and Wuhan is no exception. Major strata at both banks of the Yangtze River include soft soil with deep overburden that can easily lead to settlement deformation, various sand layers in the middle and rock stratum below 50 m from the ground surface. Groundwater with hydraulic relation with the river water poses a huge threat to the construction of this project. Before conducting large-scale construction of subway works, we have conducted in-depth research, summed up a set of dewatering construction technique by making use of deep wells, successfully solved the problem about influence of groundwater on the construction .

During the construction, some high-challenge solutions such as overlapping tunnel construction with the vertical clearance of 2 m and comprehensive technique for subway tunnel construction in karst areas are presented.

5. In view of the civil works, a number of excellent techniques are adopted to solve all kinds of difficulties.

To realize the continuous transfer on same platform of Hongshan Square Station and Zhongnan Road Station, difficulties such as interaction with nearby multi-bore tunnel during construction at short range, stress and deformation control for the completed tunnel caused by tunnels built later, assessment on environmental vibration caused by subway trains and guarantee of earthquake-resistant behavior of tunnel etc. are conquered.

the strata in ancient river course of the Yangtze River, However, the covered top-down excavation method is

adopted for this station due to traffic demand, and the steel pipe column supporting the top plate must be capable of bearing the temporary load during construction period and the permanent load during operation period. In this Project, HPE under reamed pile is adopted to solve the problem of bearing capacity and AM platform positioning technique is used to satisfy the requirement for 1% vertical perpendicularity.

In addition, we also put forward the technical solutions for construction of tunnel running through karst areas and strata rich in gas as well as those passing through railway and low building complex etc., to make great efforts to complete URT Line 2.

6. Fitment work is such designed to make style perfectly match with the function on the basis of giving priority to functions and the overall style is concise but magnificent. During the design, opinions from the public are solicited and all stations are characterized by humanistic environment and concern.

7. Signal system uses the physical protection mechanism for data transmission system for the first time in China, i.e. making use of the optical fiber line auto switch protection system (OLP) for optical fiber protection, so as to improve the reliability of signal data transmission.

8. Integrated refrigeration station is used for the first time in China, to realize the optimal interest on the whole through design optimization, shop prefabrication and high-efficiency energy-saving control etc.

### **III. Transparency and Integrity in the Whole Process of Project Implementation**

The engineering consulting service chooses the transparent, high-efficiency and competitive bidding procedure. Our Company will always provide professional, objective and impartial service and suggestions to the owners on the premise of quality guarantee.

During the construction, the whole bidding procedure including investigation, design, construction, supervision, consulting and material & equipment procurement etc. is performed in strict accordance with relevant regulations on the basis of openness, fairness and justice, to cover the entire scope of work. In addition, the first-class consulting & appraisal agency is introduced to assess and demonstrate the technical achievements, and the technical transparency and openness are realized.

Through contract management, quality management and progress control, activities such as design, consulting, construction, scientific research and acts of the contractors etc. are coordinated efficiently, so as to achieve the management targets of engineering quality, progress and investment control.

The construction process is open, transparent and legal. After several rounds of engineering consulting as well as auditing and monitoring conducted by professionals, no any circumstance that violates the professional ethics of consulting engineer is discovered.

### **IV. Sustainability and Respect for Environment**

Passenger volume has subject to a sustainable growth since this Project is opened to traffic and thus its resistance to financial risk is increased accordingly. In ordinary days, the passenger transport intensity is close to 650,000 person/day, over 1/2 of the entire network in Wuhan City; while in holidays, the value is approximately 30,000 person/km per day, twice the average passenger transport intensity in China. The high level of passenger flow ensures the

project reliably. According to the statistical data, the daily  
be saved by 200,000 hours every day after Line 2 being  
opened to traffic and it is a good news for sleep-deprived citizens. Nearly 100,000 employment  
opportunities are created during the construction and after its operation.

During the project implementation, special attention is given to the engineering measures  
necessary for environmental protection. Detailed standards for environmental protection are  
established. During the initial phase, the section from start point of the line to Jinse Yayuan  
with the length of 3.03 km is changed from elevated laying mode to underground construction  
in view of related requirements for environmental assessment, to avoid noise pollution on  
nearly 15,000 citizens in Changqing Huayuan Community. Steel-spring floating slab track bed  
and anti-vibration pad etc. are laid along the entire line, 23,100 linear meters per track in total,  
among which, anti-vibration design has been improved and totally 7,700 linear meters of  
steel-spring floating slab track bed per track have been laid as a special measure of vibration  
mitigation in the concentrated residential area and the section of historical relics in Jiangnan  
Road along this line.

In this project, the investment in environmental protection reaches RMB 86.15 million Yuan,  
accounting for 5.8% of total construction investment.

Line 2 has, in substitution for ground transportation to carry passengers, greatly reduced the  
travel time and fuel consumption and correspondingly lowered down the pollution of ambient  
air due to exhaust gas from all types of vehicles. According to estimation, total amount of SO<sub>2</sub>,  
NO<sub>x</sub>, CO and CH<sub>4</sub> exhausted can be decreased by 5,423.5 t approximately every year.

For civil works, the line profile is optimized and reasonable station spacing is determined; in  
addition, reasonable operation organization plan is determined and good energy-saving  
equipment and measures are selected, to greatly lower down the energy consumption. Energy  
conservation throughout the year is about 15 million kW·h with the energy-saving efficiency of  
12.7% and it satisfies the requirement for sustainable development.

Top-head platform in Changqing Car Depot of Line 2 is 166,648 m<sup>2</sup>, with composite land  
utilization rate 50% and building area for comprehensive development 538,335.73 m<sup>2</sup>,  
enabling 5,080 households, with the economic value up to RMB 7.63 billion Yuan. Above the  
land for Zhongshan North Parking Lot, the planned area of commercial residential building is  
about 100,000 m<sup>2</sup> and total quantity of households is nearly 1,000. Vehicle base will  
concurrently consider the construction mode with residential buildings above it, in compliance  
with the design target of intensive land use. Land revenue from intensive land use will be the  
capital fund for further development of the costly subway traffic.

Rail Transit Line 2 is a perfect model for organic combination of urban construction with  
economic development and cultural inheritance and stands for the pursuit of several  
generations of Wuhan citizens and the hardwork of thousands of people.