Why do you think this project should receive an award? How does it demonstrate:

- innovation, quality, and professional excellence
- transparency and integrity in the management and project implementation
- sustainability and respect for the environment

Crossing the Pearl River Estuary, Shiziyang Tunnel connects Guangzhou City and Dongguan City of Guangdong Province, being a key project of the Guangzhou-Shenzhen-Hong Kong High Speed Railway and the key project of the southern extension of Beijing-Guangzhou High Speed Railway to Shenzhen and Hong Kong. It is also the first underwater railway tunnel in China, honored as "China's Century Railway Tunnel".

1. Many Difficulties in Project Construction and Rich Achievements in Innovation

Major challenges for Shiziyang Tunnel construction lie in the following aspects:

1) High running speed: with the design speed of 350 km/h, it is an underwater tunnel with the highest running speed in the world.

2) Long tunneling length: each section of the tunnel is 10.8 km long, in which shield section is 9,340 m. It is the longest underwater tunnel of China, only second to Channel Tunnel.

3) Complex and varied strata: lengths of shield through bed rock, half-rock and half-soil and Quaternary strata respectively account for 73.3%, 13.3% and 13.4% of overall tunneling length; maximum uniaxial compressive strength of bed rock is 82.8 MPa, the filtration coefficient of bed rock layer is up to 6.4×10^{-4} m/s, and the maximum quartz content is up to 55.2%.

4) New construction organization technologies: four shields and two dockings in ground are adopted in tunnel construction. It is the first tunnel with docking in ground construction in China.

5) High water pressure: the maximum water pressure on the tunnel is up to 0.67 MPa. It is the tunnel with the maximum water pressure among the built underwater tunnels in China.

6) High safety standard: tunnel accesses are located in planned urban area and wave crest of micro air pressure at tunnel entrance are strictly controlled. It is the first underwater railway tunnel in China and with high disaster prevention and evacuation standards.

Main innovation achievements of the Project are as follows:

1) Structure selection technology: it addresses lining structure selection matched with stability of surrounding rock and reliability of disaster resistance of structure, i.e. double lining structure of "segment + concrete lining" is adopted for weak strata and the single segment lining is adopted for bed rock section, which ensures overall stability of the structure under fire, explosion and other accidental load effect and brings favorable economic benefit.

tructure: for weak strata, set reinforced concrete lining in inner side of segment lining and the concrete filling in tunnel floor as reinforced concrete longitudinal beam to form a spatial structure system of "segment + inner lining + longitudinal beam at tunnel bottom", so as to improve longitudinal rigidity of the structure, reduce dynamic stress and soft soil subsidence of strata and ensure smoothness of the tracks. The spatial structure can reduce 35% and more vertical vibration acceleration, and the maximum plastic deformation of soft soil due to dynamic cyclic loading is no more than 30 mm.

3) Docking in ground technology: rock stratum shield docking is developed, so cutter heads of shields are mutually contacted in docking to improve reliability in the duration: when a shield breaks down, another shield can be used to complete the construction of residual sections. Above condition occurred in actual construction, but docking was successfully completed.

4) Lining structure test and structure optimization technology: established the structure testing platform of load patterns with divided calculation of water and soil, carried out the physical model and prototype tests for tunnel-stratum interaction, revealed the structural mechanic characteristics in combination with site tests, thus to confirm the structure parameters properly.

5) Disaster prevention and evacuation technologies for underwater tunnel of the High Speed Railway: the first underwater disaster prevention and evacuation location is set in the lowest section of the tunnel. Cross passage spacing at the point is reduced to 300m from 500m of other sections, and the water firefighting system is set to maximize rescue efficiency.

6) Buffer structure technology at tunnel entrance: the systematic model tests and analysis for aerodynamics effect are conducted for the first time for twin-bore single track extra-long high speed railway tunnel with running speed of 350 km/h. Buffer structure design at tunnel entrance is proposed and the open buffer structure at tunnel entrance is developed to effectively reduce micro air pressure wave at the entrance.

The above mentioned innovation achievements have settled difficulties during construction of the Shiziyang Tunnel Project and ensured a superior, safe and reliable construction. Now the Shiziyang Tunnel has been in safe operation for over 1,200 days, all kinds of CRH train sets have passed the tunnel safely for over ten thousand times and near 80 million passengers in total have been handled. The Shiziyang Tunnel combines high speed railway technologies in China and modern shield technologies, representing construction technologies of underwater shield tunnel in China and the world.

ween Shiziyang Tunnel and Abroad Similar Projects

Items for Comparison	Abroad Similar Projects	Shiziyang Tunnel	Contrastive Analysis
Construction conditions of shield tunnel of high speed railway	Weak strata; water pressure of 0.6 MPa; the maximum length of shield section of 7,160 m; speed of 300 km/h.	Complex strata and with long distance passing bed rock strata; water pressure of 0.67 MPa; length of shield section of 9,340 m; design speed of 350 km/h	Most complex and difficult
Structure selection technology	Single lining in general; double lining is adopted in Japan	Select based on strata stability and reliability of disaster resistance of structure	International advanced
Docking in ground technology	Freezing docking or engaging docking with small diameter shields in Japan	Advanced grouting and directly contacted docking of cutter heads of shields	International advanced
Spatial design method	No report	Overall special structure of "segment + inner lining + longitudinal beam at tunnel bottom"	International leading
Structure test method	Study on influence of water pressure on the structure is difficult to carry out	Ring band is used for water pressure simulation. Water pressure and soil pressure are loaded separately.	International leading
Disaster prevention and evacuation design	Disaster prevention and evacuation location for single-bore double-track tunnel	The first disaster prevention and evacuation location for twin-bore single-track underwater tunnel	International leading
Buff structure design	No buff structure for twin-bore single-track tunnel	Buff structure with varied opening and interval for twin-bore single-track tunnel	International leading

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…uring Project Management, Great Achievement in Management

From project demonstration and approval to project construction, the construction concept of "constructing quality project with transparency, efficiency and honesty insisted" is adhered during the whole construction process of Shiziyang Tunnel of Guangzhou-Shenzhen-Hong Kong High Speed Railway.

It took 6 years to complete the project demonstration and approval in earlier phase of the Project from 1999 to 2005. Opinions from the public and shareholders have been considered and approval has been obtained from competent authorities at different levels with relationships handled among project scheme, urban planning, port and pier along the line, Shiziyang channel and the marine biological reserves in the early stage work of alignment, land acquisition and resettlement, and environmental impact assessment.

FIDIC idea is implemented in the project construction, and all the bidding work have been carried out by insisting on the principles of open, fair and just, including investigation, design, construction, supervision, consultation, materials and equipment controlled and supplied by Party A, thus to cover all the bidding contents.

The Project is completed and put into operation after five and a half years, and the construction is kept transparent and compliant with laws and regulations. In addition, all indicators for underwater tunnel of world-class high speed railway have been up to after the engineering consulting, and audit and supervision from the professional agencies.

3. Sustainable Development, Respect of Environment and Improving of Public Welfare

The environmental protection concepts were implemented during the route and site selections, and during the construction of the Project. The tunnel scheme was used for crossing Shiziyang to avoid affecting the Breeding and Protection Zone of the Economic Fish in the Pearl River Estuary, reserves of juvenile fishes and shrimps, and Humen International Port with an annual cargo handling capacity up to hundred million tons, and ensure the sailing safety of main sailing channel of Shiziyang. For the construction method of the tunnel, it used the shield tunneling method with good security and waterproofing and little leakage water after the sufficient study. The construction organization scheme of docking in ground was used to avoid building shield shaft on Sandy Island and Tiger Island, and further reducing the impact to surrounding environment of the Project. The Project gets great achievements in environmental protection.

The construction and operation of the Project can save land and energy, reduce pollution, and realize the sustainable development of environment. The tunnel scheme can save the valuable land resources on both banks of Shiziyang. Residue soil discharged from shield tunneling is as backfilling material of subgrade after being improved, reducing the pollution of solid wastes to the environment. The tunnel entrance is set with new type entrance buffer structure, ressure wave at the entrance to the acoustic environment. Various energy conservation measures have been taken for the Project to meet requirements of sustainable development. The precast reinforced concrete segments of the tunnel are fabricated and cured in factory, reducing the energy consumption per product. Entrance and exit of the tunnel are set with canopy to beautify project landscape and reduce energy consumption for drainage in the tunnel.

After the tunnel is completed and opened to traffic, the railway travel time from Beijing and Wuhan to Shenzhen is respectively shortened to 8.5 h and 4 h from 29 h and 13 h, strengthening the contacts of northern China, middle part of China and Pearl River Delta. Only in 2014, the passenger throughput of Shiziyang Tunnel was up to 25.25 million with revenue about RMB 1.7 billion Yuan. As Shenzhen-Hong Kong High Speed Railway will be opened and China High Speed Railway network is gradually formed, the passenger throughput of Shiziyang Tunnel will be increased continuously, further enhancing the earning capability of the Project, and providing a reliable guarantee for the sustainable development of the Project.