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

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

Yichang – Wanzhou Railway passes through various economic zones in Yichang, Enshi and Wanzhou, has a total length of 377 km and a max height difference of 880 m. 70 percent of this railway runs through karst areas with extremely difficult and complex natural conditions. During the construction of karst tunnel, there are large-size karsts and underground rivers, where large-scale water inrush and mud burst can easily happen. The construction difficulty is rare in the world and the project implementation is extremely arduous. However, the construction of Yichang - Wanzhou Railway has conquered major technical difficulties such as deep karst exploration, high-pressure water-rich fault zone, and construction of bridges in deep-cutting ravines etc., thus successfully completed the construction of railway along the river, created worldwide wonder in the history of railway construction.

I. Brilliant Achievements in Technological Innovation

(I) Innovated Key Technologies for Tunnel Construction Crossing Deep Karst and High-pressure Water-rich Fault Zone

In Yichang – Wanzhou Railway, there are 91 tunnels in complex karst areas where the buried depth of karst reaches 200 – 1,000 m, and hidden karsts in high-pressure water-rich cavity and underground rivers are widely distributed and complicated. Among those tunnels, eight are rated as of Grade-I Risk Tunnels and 26 as Grade-II Risk Tunnels. More than 1,100 karst caves are encountered during the construction. The high-degree construction difficulty and high risk induced by their wide distribution, large volume and high water pressure are rare in the world. Relying on technological innovation, this railway successfully passes through more than 20 underground rivers, exceeding 30 large high-pressure water-rich fractures, over 100 large-size karst caves, and handles with 1,088 karsts of all kinds. The initiative “energy-releasing & pressure reduction” technique has solved a worldwide problem of tunnel construction in high-pressure water-rich filling cavity. This non-conventional technique provides special-purpose on drain gallery and realizes the safety construction of main tunnel under low or non-pressure conditions through bursting the cavity, actively discharging water, mud, sand and stone, and releasing high potential energy stored in the karst cave. The key technologies include the determination of safe laccolith thickness, detection and locking of cavity interface, and one-off bursting and uncovering of cavity. In view of the complex karst form, a new method for assessment of karst cave stability is put forward.

More than ten new tunnel structures, such as arch + cover separation type, revetment + single-pressure ring wall type, revetment + integral type, slab (beam) + integral type, arch bridge + separated type, pile foundation + integral type, and composite foundation + integral type etc., are developed according to local conditions. Furthermore, remote video monitoring systems for tunnel deformation, internal force, water pressure monitoring, and drainage tunnel are established to ensure the structural long-term safety.

New information-based composite grouting technology of “zoning” positioning, external blockage
“U-shaped deepening” has been developed. It can divide the tunnel water zones according to the geological information such as water volume and formation fragmentation exposed through boreholes, to carry out the dynamic grouting separately. The key technologies such as implementation of full-section grouting through hole arrangement on upper benches only, working without construction of long pipe shed in workshop, and grouting effect assessment through hole imaging etc., have been created. Therefore, the problems of large construction section for curtain grouting through full-section hole arrangement and high safety risk, and high difficulty and risk in expanded excavation workshop during the construction of workshop pipe shed can be solved.

A risk control system for karst tunnel construction has been established. Based on comprehensive analysis on engineering geological & hydrogeological conditions such as scale of regional faults, development degree of underground rivers and water storage structure etc., the scale and damage degree of water inrush and mud burst in tunnel can be judged and the geologic hazards in karst tunnel can be classified for further level-to-level management. In particular, a construction disaster warning system including video monitoring, audible-and-visual alarm, emergency communication, emergency lighting, evacuation route, escape equipment, emergency drainage and emergency power supply is established.

(II) Innovated Technology for Deep Karst Exploration under Complex Topographic & Geological Conditions

In the western Hubei Province, intensively developed karsts, large-size water-rich cavities, underground rivers, and karst conduits are widely distributed. They are complicated forms and characterized by multiple-period, multi-layer, and deeper towards.

A new method for detecting deep karst and rock integrity through high-frequency magnetotelluric has been developed for the first time, and it solves the world-wide problem of geological prospecting in complex karsts. Abnormal spatial distribution character of layers with different electrical properties, deep karsts, fault structure and non-uniform geological bodies caused by 10–100 kHz magneto-telluric fields under complicated topographic conditions, has been found through observation and research. Then two-dimensional tensor based high-frequency magnetotelluric survey method and effective detection and depth calculation method are developed for deep karsts accordingly.

The innovated forecast method for water inflow in the karst tunnel provides reliable technical support for early warning of water inrush risk during the karst tunnel construction. The watershed hydrological model is used for forecasting water inflow in karst tunnels and determining the hydrologic process in underground rivers in case of rainfall for the first time. Then a new method for forecasting the peak flow and time of water inflow has been obtained, and the difficulties in early warning of water inflow during the construction of karst tunnel has been overcome.

(III) Innovated New Bridge Structure Type in Complicated Mountains Areas

Considering the abrupt terrain and deep-cutting valleys along this line, new bridge structure types such as long-span concrete continuous rigid frame-flexible steel tube arch composite bridge, asymmetric arch bridge, etc., have been proposed. There are totally 32 bridges of complicated special structure in this project.

A long-span concrete continuous rigid frame-flexible steel tube arch composite bridge has been
Pioneered construction technology of beam first then arch, i.e., cantilever construction and then continuous vertically downward rotating closure has been developed. A new design method that continuous rigid frame bears the dead load, composite structure bears phase-II dead and live loads, and beam and arch bear loads according to the stiffness has been put forward. Thus the overall vertical stiffness and the crossover capability of the continuous rigid frame railway bridge can be increased greatly, and the later creep of long-span concrete structure can be controlled. High-performance concrete for long-span concrete railway bridge is developed for the first time, and the crack resistance and durability concrete structure are enhanced. The innovated new technology for vacuum concrete placing by large-diameter steel pipe can improve the concrete compactness. The development and application of vibration isolation technology using rubber spring can change the irregular high-frequency exciting vibration of the bridge into linear harmonious low frequency vibration, thus effectively reduce the influence of vibration on environmental sensitive areas.

The innovated asymmetric concrete-filled steel tubular (CFST) arch bridge can overcome the difficulties in constructing bridge under complicated topographic & geological conditions. Yesanhe Bridge has steep cliffs at both banks, and relatively great height difference. In view of this, a new structure type of asymmetric CFST arch bridge is proposed to solve the problem of unbalanced load bearing of arch ribs. The lattice system of longitudinal and transverse prestressed concrete beam for the railway was adopted to solve the problem of insufficient transverse stiffness of the flexible suspension rod bridge. The 124 m-span Yesanhe Bridge is hailed as the “most beautiful railway bridge” in mountainous areas by virtue of its perfect integration with the cliff slopes.

This Project has been awarded with 13 invention patents, eight utility model patents, two national-grade normalized construction methods, two provincial-and-ministerial normalized construction methods, and one special prize and two first prizes of provincial-and-ministerial level.

Its innovation achievements have been incorporated into industrial standards such as Code for Geophysical Prospecting of Railway Engineering, Technical Guide for Advance Geological Forecast for Railway Tunnels and Temporary Provisions for Risk Assessment and Management for Railway Tunnels etc. Lu Yao-Ru, Academician of the Chinese Academy of Engineering spoke highly of the construction of this project and gave the opinion that “The construction of Yichang - Wanzhou Railway conquered difficulties in karsts, created a worldwide miracle, and would better promote the development of construction technology.”

II. Adhere to Environmental Protection and Promote Sustainable Development

During the implementation of this project, the advanced concepts such as environment friendly rout selection, site selection and construction are well adhered. This project takes a leading position in the bridge construction in China, Asia and the world in terms of their types, spans and heights adopted according to the local geological conditions. Design and construction technology of long tunnel in areas with extensively developed karsts has been presented. Therefore, this project can better adapt to the complicated topographical and geological conditions, reduce the
The high-risk concept of railway tunnel is put forward and the risk management theory is introduced into the field of railway construction for the first time. Special system for high risk prevention during the construction of Yichang – Wanzhou Railway is established; tunnel risk assessment, risk level classification, and level-to-level management of tunnel risk are adopted; level-to-level management methods for design, drilling, inspection and interpretation of boreholes through advance geological forecast and prediction are formulated and incorporated into the process management, thus the capacity of safety production is effectively improved.

The completion of Yichang – Wanzhou Railway will establish a fast-speed Shanghai – Wuhan – Chengdu railway corridor. From Chongqing to Wuhan, the haul distance will be decreased by 370 km and the travel time will be reduced by 10 hours. It can further shorten the space-time distance between the southwest China and the central China, and Yangtze River Delta Region, tighten the connection of Yichang, Enshi, Wanzhou in the Three Gorges Reservoir Area with surrounding and developed areas, speed up the communication and cooperation with surrounding areas, and greatly promote the development of industry, tourism, logistics, and the growth of living standard along this line. In 2013, Yichang, Enshi, and Wanzhou provided services to the tourists up to 71.58 million persons and the total tourism income reached RMB 45.1 billion Yuan.

III. Transparency and Integrity in Project Implementation

The planning studies and construction of the Project began in 1997 and 2004, respectively. During that period, a lot of studies and demonstrations on the technical standards, routing options, and construction scales were carried out. NPC deputies at various levels also provided their suggestions on the construction to the governments at all levels. The local governments, the public and the stakeholders were fully consulted on the planning, site selection, land acquisition, demolition and environmental impacts.

During the construction, the FIDIC concepts are well adhered; the FIDIC contract management is strictly performed; rules for Yichang – Wanzhou Railway Project in terms of construction, planning, quality, supervision, contract, materials and equipment, and measurement and payment management are established. The bidding processes for survey, design, construction, supervision, consultant, and the materials and equipment are standardized, thus it is implemented on the basis of openness, fairness and justice over the entire scope of work. The construction processes are open, transparent and legal. All surveyors, designers, and consultants devote themselves to rendering objective, fair and professional services to the owner, stick to the principle of technology priority, and maintain the owner’s interest. Through standardized construction management and continuously innovated management modes, the project quality, schedule, investment control, environmental protection and such construction objectives are realized; basic theory and management system for railway construction are enriched, and a lot of engineering consulting and management talents are trained.

Carrying a century of historical changes and the expectations of Chinese, Yichang – Wanzhou Railway has realized the hopes of the people living in Wuling Mountain, Yangtze River and Qingjiang River for modern cultivation and happy future, and also achieved an unprecedented leap