Development of Inland Shipping and Construction of New Three-Gorges Ship Channel

Xinqiang Niu(✉), Jundong Wu, Yachao Wang, Xiaowei Wang, Hao Zhou, and Yu Zheng

Chang Jiang Survey, Planning, Design and Research CO., LTD., 1863 Jiefang Avenue, Jiang'an District, Wuhan, China
niuxinqiang@cjwsjy.com.cn

Keywords: Inland shipping of China · The Yangtze River shipping · New three gorges channel · Freight volume

1 Development and Goals of China Inland Shipping

1.1 Development Status

Inland waterways in China flows from west to east, affects the economy of South and North China, communicates with the ocean. It has the comparative advantages of large capacity, less pollution, less land occupation, low cost and low energy consumption. By the end of 2020, the navigable mileage of inland waterways in China was about 127,700 km (Fig. 1), and the inland water freight volume was 3.815 billion tons, ranking first in the world's inland rivers.

1.2 Development Goals

During the "Thirteenth Five-Year Plan (2016–2020) period", China's inland water transportation (IWT) has played an important supporting role in building a comprehensive transportation system and serving the implementation of the national strategy (National Development and Reform Commission 2021). During the "14th Five-Year Plan period", China has entered a stage of high-quality development. The "14th Five-Year Plan" and the strategy of building a transportation powerhouse require IWT to strengthen its role as an important channel and hub in the comprehensive transportation system. The overall goal of IWT at this stage is to basically build a national high-grade waterway of 25,000 km with "four vertical, four horizontal and two networks" by 2035; at the same time, promote the integrated planning and construction of port hubs, improve the collection and distribution system, and vigorously develop rail-water combined transport, water and water transfer, and promote the high-quality development of intermodal transportation (Table 1).

Y. Li et al. (Eds.): PIANC 2022, LNCE 264, pp. 10–15, 2023.
https://doi.org/10.1007/978-981-19-6138-0_2

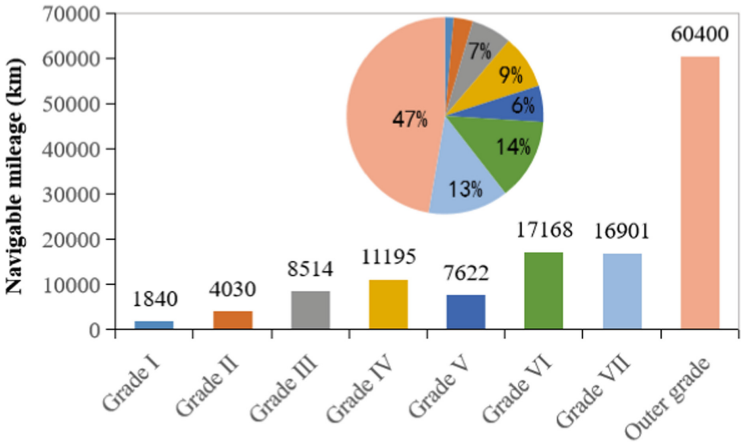


Fig. 1. In 2020, the mileage (km) and proportion of various grades of inland waterways in China

Table 1. Main indicators of China water transport development during "14th Five-Year Plan period" (MOT 2022)

Indicator	Year 2020	Year 2025	Increase
New and improved inland waterway mileage (km)	/	/	About 5000
Newly added national high-grade waterway (km)	/	/	About 2500
Adaptability of passing capacity of large specialized coastal wharfs	>1.0	>1.1	/
Railway entry rate of major coastal ports (%)	>90		/
Average annual growth rate of containerized rail-water combined transport (%)	15		/

2 Main Problems of the Yangtze River Shipping Development

2.1 Development Status

The Yangtze River system is an important part of China's inland shipping network, with a navigable mileage of about 64,700 km, accounting for 50.7% of the national inland shipping mileage. At the same time, it is the golden waterway with the busiest IWT and the largest water transportation volume in the world. The freight volume has ranked first in the world for 17 consecutive years since 2005. In 2021, the freight volume of the Yangtze River mainstream will reach 3.53 billion tons (Fig. 2).

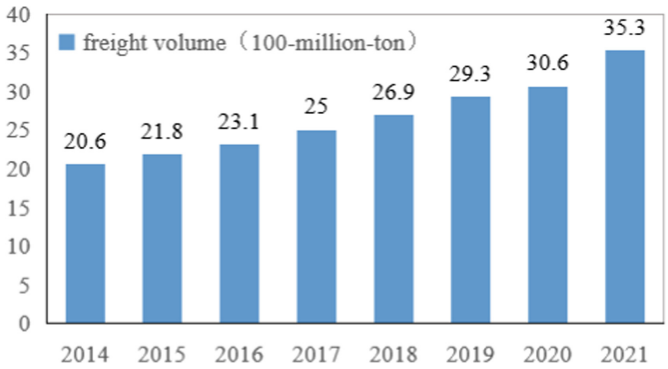


Fig. 2. Development of freight volume in the main stream of the Yangtze River

2.2 Main Problems

In order to implement the concept of the Yangtze River Protection and green development, and pursue the goals of carbon peaking and carbon neutrality, the shipping of Yangtze River needs to comprehensively promote the systematization governance of mainstream waterways in accordance with the general idea of "deep downstream, smooth middle reaches, and extended upstream of the Yangtze River", improve the scale of the waterway and the passing capacity to create a smooth, efficient, safe and green golden waterway. Three main problems need to be solved to achieve the construction goals and promote the high-quality development of Yangtze River Shipping. The first is that the shipping technology system such as channel standards, ship size, and navigable building scale cannot meet the strategic requirements of the golden waterway. Second, there are bottlenecks in the Yangtze River waterway, including the four upper cascade high dams that block the further extension of the Yangtze River waterway to the upstream; the water depth of the middle reaches is relatively deeper compared with the upper and lower reaches, making it difficult to rectify and restricting the development of 10,000-ton river-sea direct ships; the channel conditions of the downstream river are not stable enough, and ship density of local regions is relatively high. The third is that the demand for passing through the Three Gorges Ship Lock has exceeded the design capacity, and the backlog of ships is serious. The efficient and smooth shipping of the Yangtze River needs to focus on solving the problem of insufficient passing capacity of the Three Gorges Hydro-Junction because it is a throat hub of the Yangtze River mainstream.

3 Construction of New Three Gorges Channel

3.1 Development Status and Freight Volume Forecast

Freight volume passing through Three Gorges ship locks has grown explosively after the completion of the Three Gorges Project. In 2011, the traffic volume exceeded 100

million tons, reaching the planned traffic volume 19 years ahead of schedule; in 2021, the total traffic volume reached 151 million tons (Fig. 3). The Three Gorges Hydro-Junction has become the core issue that restricts the further development of the Yangtze River shipping. According to shipping development of the Mississippi River and the Rhine River, it can be seen that the demand for IWT is closely related to the stage of economic development and urbanization development, and will continue to grow until the end of post-industrialization and urbanization (Fig. 4). At present, China is in the transition stage from the middle to the late stage of industrialization and the middle stage to the late stage of urbanization. According to forecast of several domestic authoritative institutions, freight demand of the Three Gorges Hydro-Junction will continue to increase in the medium and long term (Fig. 5). It is predicted that the freight demand will reach 300 million tons in 2050, exceeding the passing capacity of the existing ship locks (CIECC 2021). Therefore, it is proposed to build a new Three Gorges waterway to solve the problem of insufficient passing capacity of the Three Gorges Hydro-Junction.

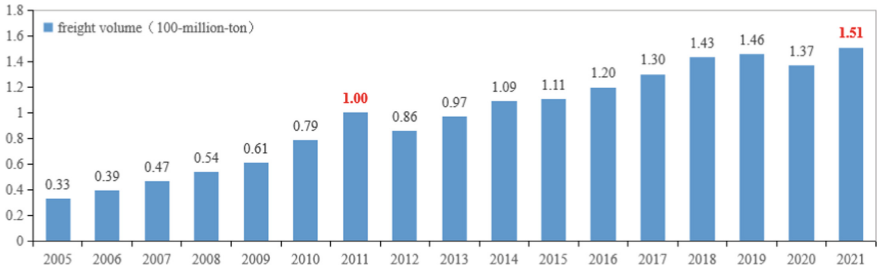
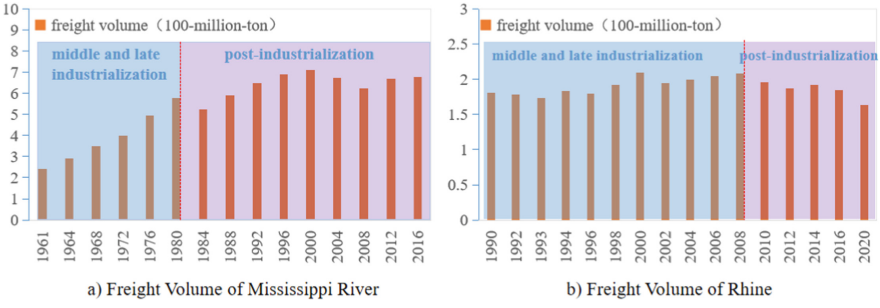


Fig. 3. Freight volume of the three gorges ship lock over the years



a) Freight Volume of Mississippi River

b) Freight Volume of Rhine

Fig. 4. Freight volume of mississippi river and rhine over the years

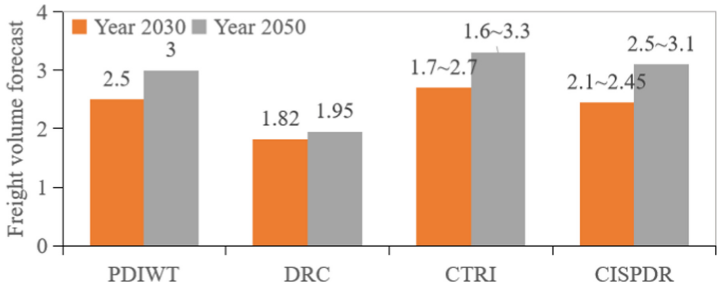


Fig. 5. Freight volume forecast of the three gorges hydro-junction by authoritative institutions

3.2 Construction Standards

The New Three Gorges Waterway Project plans to build two-line ship locks at the Three Gorges Project, and dismantle the original No. 3 ship lock of the Gezhouba Project and build a new two-line large ship lock. The effective size of the new ship lock chamber is 280 m × 40 m × 8.0 m (length × width × minimum threshold water depth), and the maximum designed ship shape is 130 m × 22 m × 5.5 m (length × width × depth of immersion). The one-way throughput capacity of the Three Gorges Hydro-Junction will reach about 180 million tons, which meets the demand of the predicted transportation volume in 2050 after the completion of the project, and leave a certain space for development.

3.3 Key Research Questions

The construction of the New Three Gorges Waterway has large-scale, high technical indicators, and many constraints, and there are four issues that need to be studied, which include navigation hydraulics, large-scale long-distance navigation tunnels, super-wide and high water-head herringbone door and hoist equipment, and navigation during construction. **Key issue 1:** the New Three Gorges Channel has a high navigable water head. It has broken through the technical indicators of ship locks built at home and abroad in terms of ship lock water delivery efficiency, energy dissipation of ship lock chamber, and valve air defense. Higher requirements have been put forward for these indicators. **Key issue 2:** a excavated navigation tunnel of the new shipping channel line IV lies on the left bank of the Three Gorges Hydro-Junction. The navigation tunnel has long distance, large cross-section scale, large fluctuation of the upstream water level, and high navigation standards. Since it lacks practical experience of large-scale navigation tunnels, researches on key issues such as navigation safety, fire safety and ship passage way are essential. **Key issue 3:** technical indicators such as minimum water depth on shiplock sill, submerged water depth of the herringbone door operation, and the width of shiplock chamber exceed the built shiplocks, which puts forward higher requirements for normal operation of the herringbone door and hoist equipment. It is necessary to conduct a comprehensive study on the key technical problems such as the structural force and operation mode of the herringbone door, and propose a technical solution for the herringbone door and hoist that meets the operation

requirements. **Key Issue 4:** During the construction period, the No. 3 ship lock of the Gezhouba Hydro-Junction needs to be dismantled. In addition, the deep excavation of the Sanjiang Channel will occupy part of the navigation width, which will affect passing capacity. At the same time, considering further increase in the transportation volume during the construction period, it is necessary to combine the transportation system of overturning the Gezhouba Hydro-Junction, focusing on the navigation problems during the construction period.

References

National Development and Reform Commission (2021) Making national development plans for high-quality economic and social development during the 14th five-year plan period. QIUSHI 2021(2020-6):25–35

MOT (2022) The 14th five-year development plan for water transport. Ministry of Transport of the People's Republic of China, Beijing

CIECC (2021) General report on preliminary demonstration and research of deepening the new three gorges waterway. China International Engineering Consulting Corporation, Beijing