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Current Status and Trend of China's Port Infrastructure Construction

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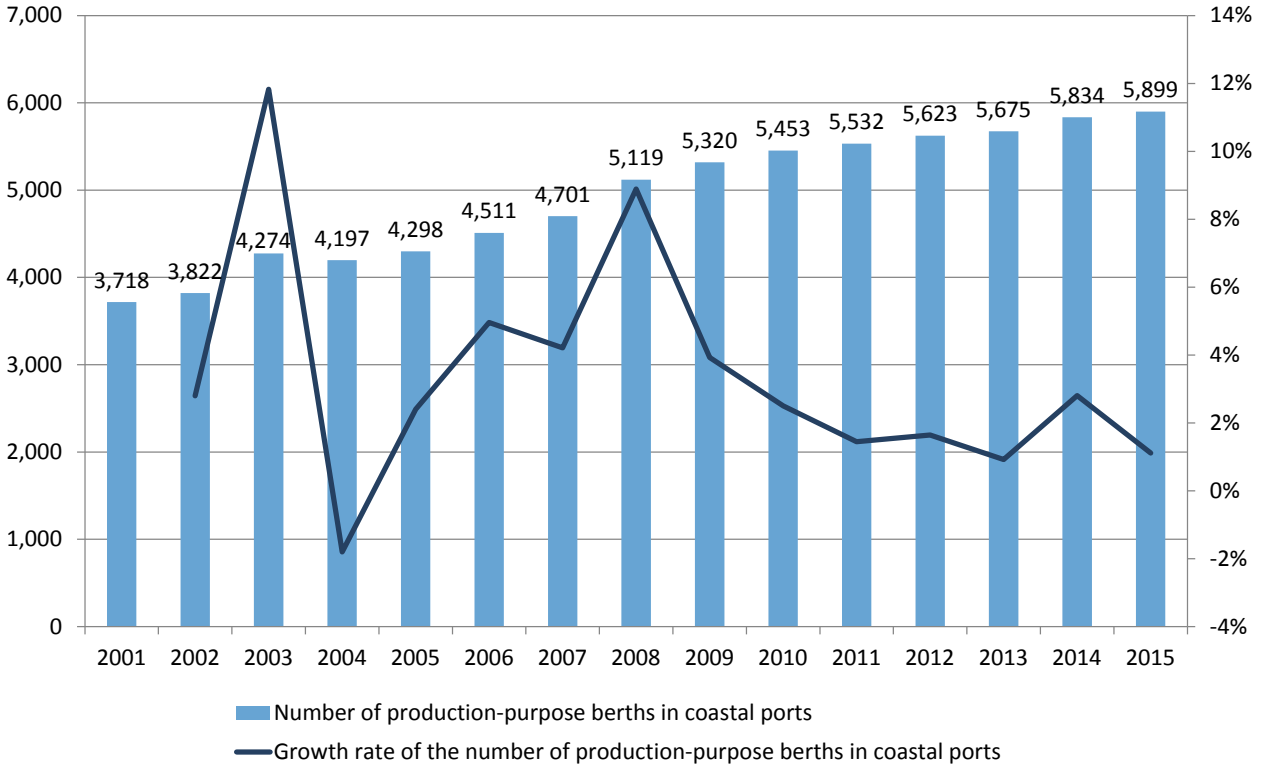
China's port infrastructure construction

Since the founding of the People's Republic of China (PRC) in 1949, China's port development can be generally classified into four stages or periods, namely development and construction restoration, fast-pace development and construction, high-speed and high-grade development and construction, and stable development and construction[1]. During the development and construction restoration period from 1949 to 1979, the principal tasks involved expansion and renovation of existing aging terminals. With the implementation of the reform and opening-up policies and huge increases in import and export trade volumes in China during the fast-pace development and construction period from 1980 to 1999, China's ports could not meet new import and export requirements any more. The Ministry of Transport (MOT) of the PRC put forward the coastal main hub ports layout and planning and approved the construction of a batch of specialized terminals, allowing the terminal construction to pass into a fast development period. Following China's accession to the World Trade Organization (WTO), and with China's fast-pace economic development and the rise of port-neighboring industries from 2000 to 2010, China's port construction experienced high-speed development, with a rising number of high-level shipping routes. The number of production-purpose berths in coastal ports increased from 3,718 in 2001 to 5,453 in 2010, an average rise of 192 every year, after nearly one-decade persistent development. Since 2011, affected by the macro economy downturn, China's port construction entered the stable development period, which is characterized by saliently decreasing growth rates in berth numbers and cargo throughput as well as the growing number of production-purpose berths in coastal ports, which is 89 every year on average from 2011 to 2015.

Due to the constant sluggish shipping market, especially the domestic-trade shipping market, and enhanced supply-side reform of ports in recent years, the production-purpose terminal construction remains in stable development. By the end of 2015, the number of production-purpose terminals and berths owned by all the ports in China stood at 31,259, a decrease of 446 year on year. Among these ports, the number of production-purpose terminals and berths in coastal ports was 5,899, an increase of 65, and the number of production-purpose terminals and berths in inland-river ports was 25,360, a decrease of 511 (See Table 1). The number of berths for ships with a capacity of 10,000 tons and above at all ports in China was 2,221, an increase of 111 from the end of the previous year. Among these berths, the number of berths for ships with a capacity of 10,000 tons and above in coastal ports in China was 1,807, an increase of 103, and that in inland river ports in China was 414, an increase of 8.

[1] Ministry of Transport of the PRC (2011). "China Port and Waterway Construction in the Past 60 Years" in *Construction Achievement Volume*. China Communications Press.

Changes in numbers of China's production-purpose berths in coastal ports from 2001 to 2015



Graph 1 - Source: Statistical Bulletin on the Road and Waterway Transport Industry Development issued by the MOT in various years

Statistics on the number of production-purpose terminals at ports in China in 2015

Category	Unit	2015	2014	Increase (decrease) in number	YoY increase in 2015
Port production-purpose berth	Number of berths	31,259	31,705	-446	98.59
Coastal	Number of berths	5,899	5,834	65	101.11
Inland river	Number of berths	25,360	25,871	-511	98.02
Terminals and berths for ships with a capacity of 10,000 tons and above	Number of berths	2,221	2,110	111	105.26

Table 1 - Source: China Ports Yearbook 2016

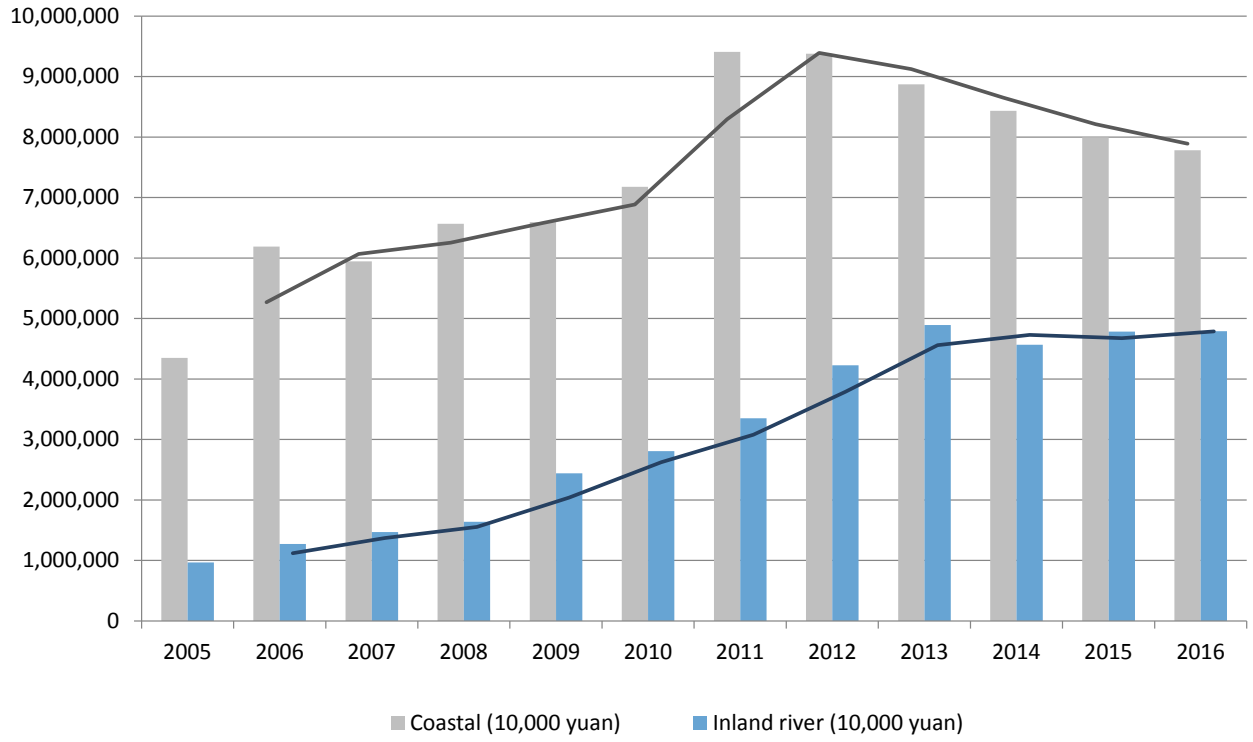
Port project investment in China

China's fixed asset investment in waterway transportation

Like the terminal investment trend, China's fixed asset investment scale in waterway transportation had been maintaining high growth during the shipping market's peak period. However, that growth was halted by the financial crisis in 2008. In view of the risks of China's economic downturn and structural adjustments of its transportation industry, the fixed asset investment in China's waterway transportation declined in 2011.

As for the changes of the fixed asset investment in waterway transportation since 2005, the fixed asset investment of China's coastal waterway transportation in 2011 reached 94.08 billion yuan (US$13.84 billion), reaching the investment peak within the recent decade. Nevertheless, because of the persisting sluggish shipping industry, the fixed asset investment showed a decreasing trend in the following years. By 2016, the investment volume was reduced to 77.84 billion yuan (US$11.45 billion). On the contrary, the fixed asset investment in China's inland river transportation basically showed a year-by-year increasing trend and totaled 48.92 billion yuan (US$7.19 billion) in 2013. After that, the investment volume growth also gradually slowed down.

Fixed asset investments in China's waterway transportation from 2005 to 2016



Note: The statistical data are those from January to November each year.

Graph 1 - Source: MOT

Examining various regions, the fixed asset investment volumes in waterway transportation in China's eastern and central areas decreased, while those in China's western areas increased year by year. According to the forecast data in China's inland port construction in 2016, China's eastern area received an investment of 20.45 billion yuan (US$3.02 billion), a year-on-year decrease of 12.8 percent, China's central area realized an investment of 18.87 billion yuan (US$2.78 billion), a year-on-year decrease of 6.2 percent, and China's western area fulfilled an investment of 14.35

billion yuan (US$2.11 billion), a year-on-year increase of 29.4 percent. As for China's coastal construction, China's eastern area received an investment of 82.89 billion yuan (US$12.19 billion), a year-on-year drop of 4.6 percent, and China's western area realized an investment of 3 billion yuan (US$441 million), a year-on-year decline of 28.1 percent. It can be seen that in 2016, the fixed asset investments in waterway transportation in eastern and central areas of China decreased, while that in western China increased.

Statistics on the number of production-purpose terminals at ports in China in 2016*

	Inland river construction in 2016	Increase from the previous year	Coastal construction in 2016	Increase from the previous year	Total investment volume in 2016
Eastern area	2,045,211	87.20%	8,289,037	95.40%	10,334,248
Central area	1,886,941	93.80%	-	-	18,86,941
Western area	1,435,405	129.40%	300,000	71.90%	1,735,405
Total	5,367,557	98.20%	8,589,037	94.30%	13,956,594

* Unit: 10,000 yuan.

Table 2 - Source: Express on Completed Fixed Asset Investment in Road and Waterway Transportation in 2016, issued by the MOT

China's key port investment projects in 2016

According to the Outline on the National Economy and Social Development in the 13th Five-Year Plan (Draft), China scheduled to implement 100 key engineering projects in next five years, involving such fields as science and technology, equipment manufacturing, agriculture, environmental protection, transportation, energy, talent, culture and education.

Among them, key projects regarding port and shipping construction include the vigorous promotion of the establishment of international shipping centers in places such as Shanghai, Tianjin, Dalian and Xiamen, and upgrading port intelligence level, which is expected to be the main direction of China's port construction investment between 2016 and 2020.

Under the guidance of China's 13th Five-Year Plan, various coastal provinces and cities are positively pushing forward their port investment and construction. In 2016, places with port projects include the bulk cargo terminal projects in Ningbo-Zhoushan Port, Meizhou Bay Port and Huanghua Port, the crude oil terminal projects in Huizhou Port and Rizhao Port, and the container terminal projects in Huizhou Port and Fuzhou Port (See Table 3).

Main coastal port projects in China in 2016

Port type	Port	Project name	Investment amount
Bulk cargo port	Meizhou Bay Port	Berths 8-15 in Luoyu operation site	First phase investment of 4.5 billion yuan (US$662 million)
	Huizhou Port	First phase of coal terminal in Tsuen Wan port area of Huizhou Port	An invested amount of about 1.69 billion yuan (US$249 million)
	Rizhao Port	Coke terminal project in south part of Shijiu port area	1.49 billion yuan (US$219 million)
	Beibu Gulf Port in Guangxi	Coal terminal at Qinzhou Port, to be in trial operation soon	1.49 billion yuan (US$219 million)
	Haikou Port	Third phase bulk terminal in Macun port area of Haikou Port	260 million yuan (US$38 million)
	Jiaxing Port	The water engineering part of grain terminal expansion project at Jiaxing Port was accepted after appraisal	220 million yuan (US$32 million)
	Zhanjiang Port	Start to build first public deepwater terminal in Donghaidao port area	900 million yuan (US$132 million)
	Huanghua Port	Third phase project at Huanghua Port was completed	4.45 billion yuan (US$654 million)
	Huizhou Port	Coal terminal in Tsuen Wan port area	2.49 billion yuan (US$366 million)
	Ningbo-Zhoushan Port	Shulanghu ore transit terminal in Qushan port area of Zhoushan Port	4.91 billion yuan (US$722 million)
Crude oil terminal	Ningbo-Zhoushan Port	Second-phase Shihua 450,000-ton crude oil terminal in Daxie port area of Ningbo-Zhoushan Port	165 million yuan (US$24 million)
	Huizhou Port	A 50,000-ton petrochemical terminal is scheduled to be built in Huizhou Port	About 290 million yuan (US$43 million)
	Huizhou Port	China National Offshore Oil Corporation (CNOOC) Oil Refinery Mabianzhou terminal at Huizhou Port	1.06 billion yuan (US$155 million)
	Huizhou Port	Huaying petrochemical fuel-oil blending and distributing center and terminal	3.2 billion yuan (US$470 million)
	Rizhao Port	Project of 300,000-DWT crude oil terminal of Lanshan port area	1.17 billion yuan (US$172 million)
	Huizhou Port	Petrochemical area in Tsuen Wan port area	290 million yuan (US$43 million)
	Huizhou Port	Terminal for fuel-oil blending and distributing center at Huizhou Port is scheduled to be completed in the second half of 2017	760 million yuan (US$112 million)
Container terminal	Huizhou Port	Huizhou international container terminal	1.96 billion yuan (US$288 million)
	Fuzhou Port	150,000-ton container terminal at Fuzhou Port was formally put to use	Total first phase investment of 1.05 billion yuan (US$154 million)
	Jiangsu Port	Second and third-phase projects of Taizhou international container terminal is now under construction	1.2 billion yuan (US$176 million)
	Dalian Port	Fourth phase project at Dayao Bay	Unknown
	Shantou Port	Phase II Project of Guangao port area of Shantou	Unknown

Tabella 3 - Source: Public information from the websites of ports in China and the websites of various provincial governments and departments in China

Coastal port layout

In the recent 20 years, China's costal ports have generally formed a preliminary port layout with a rational distribution, clearly classified levels and specific functions as well as a specialized system centering on four major cargo categories, namely coal, crude oil, ore and container. They have been playing important roles in meeting China's shipping of staple materials including energy and raw materials, supporting the fast and stable development of China's foreign trade and guaranteeing China's participation in international economic cooperation and competition.

According to the MOT-issued China's Coastal Port Layout and Planning, China's coastal ports are classified into five port groups, namely Bohai Rim, Yangtze River Delta, Southeast Coast, Pearl River Delta and Southwest Coast, based on the economic development situations and features in different areas, the ports' present statuses within an area, the shipping relations among these ports and the economic rationality for the shipping of main cargo categories, so as to form a layout of eight transportation systems, namely coal, crude oil, iron ore, container, grain, commodity vehicle, continent-island roll-on/roll-off and passenger transport.

The layout is described as follows:

1. Bohai Rim port group

Bohai Rim port group, consisting of coastal port clusters in Liaoning, Tianjin, Hebei, and Shandong, serves the social and economic development of China's northern coastal and inland regions. The layout of Bohai Rim port group is shown in Table 4.

Dalian Port, Yingkou Port, Qinhuangdao Port, Tianjin Port, Yantai Port, Qingdao Port and Rizhao Port are core ports in the Bohai Rim port group (see Figure 1). The future development of the Bohai Rim port group will benefit from mutual influences of the "One Belt and One Road" initiatives, namely the "Silk Road Economic Belt and the 21st-Century Maritime Silk Road", the China-Mongolia-Russia Economic Corridor and the New Eurasian Continental Bridge Economic Belt, which will boost the ports' construction and development.

Layout of Bohai Rim port group

Port group	Regional port cluster	Core ports in the layout	Local ports or feeder ports	Port function	Scope of service
Bohai Rim port group	Coastal port cluster in Liaoning	Dalian Port and Yingkou Port	-	Large and specialized transit, storage and transport facilities for staple bulk cargos including petroleum (especially for crude oil and its storage), LNG, iron ore and grain	Three provinces in northeast China, namely Liaoning, Jilin and Heilongjiang, and eastern part of Inner Mongolia
		Dalian Port	Yingkou Port, Jinzhou Port and Dandong Port	Container	
		Dalian Port	-	Continent-island roll-on/roll-off, passenger transport and commodity vehicle's transit, storage and transport	
	Coastal port cluster in Tianjin and Hebei	Qinhuangdao Port, Tianjin Port, Huanghua Port and Tangshan Port	-	Specialized coal-loading port	Beijing, Tianjin and other places in North China as well as some areas on its west
		Qinhuangdao Port, Tianjin Port and Tangshan Port	-	Large and specialized transit, storage and transport facilities for staple bulk cargos including petroleum (especially for crude oil and its storage), LNG, iron ore and grain	
		Tianjin Port	Qinhuangdao Port, Huanghua Port and Tangshan Port	Container	
		Tianjin Port	-	Facilities for passenger transport and commodity vehicle's transit, storage and transport	
	Coastal port cluster in Shandong	Qingdao Port, Rizhao Port and Yantai Port		Large and specialized transit, storage and transport facilities for staple bulk cargos including petroleum (especially for crude oil and its storage), LNG, iron ore and grain	Shandong Peninsula and some areas on its west
		Qingdao Port	Yantai Port, Rizhao Port and Weihai Port	Container	
		Qingdao Port, Yantai Port and Weihai Port	-	Facilities for continent-island roll-on/roll-off and passenger transport	

Table 4 - Source: Public information from the websites of ports in China and the websites of various provincial governments and departments in China

Bohai Rim port group

Figure 1 - Source: map of China main ports

2. Yangtze River Delta port group

The Yangtze River Delta port group serves the economic and social development in the Yangtze River Delta and areas along the Yangtze River by relying on the Shanghai International Shipping Center, with Shanghai Port, Ningbo Port, Lianyungang Port playing the dominant role, and fully exerting the roles of coastal ports and those along the lower reaches of the Yangtze River, including Zhoushan Port, Wenzhou Port, Nanjing Port, Zhenjiang Port, Nantong Port and Suzhou Port. The layout of the Yangtze River Delta port group is described in Table 5.

Layout of Yangtze River Delta port group

Port group	Regional port cluster	Core ports in the layout	Local ports or feeder ports	Port function	Scope of service
Yangtze River Delta port group	Shanghai Port, Ningbo Port and Suzhou Port	Lianyungang Port, Jiaxing Port, Wenzhou Port and Taizhou Port	Container	Large and specialized transit, storage and transport facilities for staple bulk cargos including petroleum (especially for crude oil and its storage), LNG, iron ore and grain	Yangtze River Delta and areas along Yangtze River Mongolia
	Shanghai Port, Nantong Port and Ningbo-Zhoushan Port	Nanjing Port	Receiving, unloading, transit, storage and transport for imported petroleum and LNG	Container	
	Ningbo-Zhoushan Port and Lianyungang Port	Shanghai Port, Suzhou Port, Nantong Port, Zhenjiang Port and Nanjing Port	Transit and transport of iron ore	Continent-island roll-on/roll-off, passenger transport and commodity vehicle's transit, storage and transport	
	Lianyungang Port	Public terminals and energy enterprises' self-use terminals at Lianyungang Port	Receiving, unloading and transshipment of coal	Specialized coal-loading port	
	Shanghai Port, Nantong Port, Lianyungang Port, Ningbo-Zhoushan Port and Jiaxing Port	-	Transit, storage and transport of grain	Large and specialized transit, storage and transport facilities for staple bulk cargos including petroleum (especially for crude oil and its storage), LNG, iron ore and grain	
	Shanghai Port and Nanjing Port	-	Commodity vehicle transport	Container	
	Ningbo-Zhoushan Port and Wenzhou Port	-	Continent-island roll-on/roll-off transport	Facilities for passenger transport and commodity vehicle's transit, storage and transport	
	Shanghai Port	-	Transit and cruise transport for domestic and foreign passengers	Facilities for continent-island roll-on/roll-off and passenger transport	

Table 5 - Source: layout plan of China coastal ports

Yangtze River port group

Figure 2 - Source: map of China main ports

3. Southeast Coast port group

Southeast Coast port group, consisting of major ports of Xiamen and Fuzhou and other ports including Quanzhou Port, Putian Port and Zhangzhou Port, serves the social and economic development of Fujian province and some places of inland provinces such as Jiangxi, and meets the requirement of three direct links of trade, mail, and air and shipping services across the Taiwan Strait. The port layout is shown in Table 6.

Layout of Southeast Coast port group

Port group	Core ports in the layout	Local ports or feeder ports	Port function	Scope of service
Southeast Coast port group	Quanzhou Port	-	Receiving, unloading, storage and transport of petroleum and natural gas	Fujian province and some places of inland provinces such as Jiangxi
	Xiamen Port	Fuzhou Port, Quanzhou Port, Putian Port and Zhangzhou Port	Container	
	Fuzhou Port, Xiamen Port and Putian Port	-	Transit, storage and transport of grain	
	Ningde Port, Fuzhou Port, Xiamen Port, Quanzhou Port, Putian Port and Zhangzhou Port	-	Continent-island roll-on/roll-off transport	
	Xiamen Port		Transit and transport of domestic and foreign passengers	

Table 6 - Source: layout plan of China coastal ports

Layout of Southeast Coast port group

Figure 3 - Source: map of China main ports

4. Pearl River Delta port group

Pearl River Delta port group consists of ports in eastern Guangdong and Pearl River Delta areas, mainly including Guangzhou Port, Shenzhen Port, Zhuhai Port and Shantou Port. Relying on Hong Kong's economic, trade, financial, information and international shipping center advantages, and consolidating Hong Kong's position as an international shipping center, Pearl River Delta port group serves South China areas and some places in Southwest China, and strengthens the exchanges between Guangdong province and inland areas with Hong Kong and Macao. The layout of Pearl River Delta port group is shown in Table 7.

Layout of Pearl River Delta port group

Port group	Core ports in the layout	Local ports or feeder ports	Port function	Scope of service
Pearl River Delta port group	Guangzhou Port and electric power-supply enterprises' self-use terminals	-	Receiving, unloading and transshipment of coal	South China and some areas in Southwest China
	Shenzhen Port and Guangzhou Port	Shantou Port, Huizhou Port, Humen Port, Zhuhai Port, Zhongshan Port, Yangjiang Port and Maoming Port	Container	
	Guangzhou Port, Shenzhen Port, Zhuhai Port, Huizhou Port, Maoming Port and Humen Port	-	Receiving, unloading, transit, storage and transport for petroleum and LNG	
	Guangzhou Port and Zhuhai Port	-	Transit and transport of iron ore	
	Guangzhou Port and Shenzhen Port	-	Transit, storage and transport of grain	
	Guangzhou Port	-	Commodity vehicle transport	
	Shenzhen Port, Guangzhou Port and Zhuhai Port	-	Transit and cruise transport of domestic and foreign passengers	

Table 7 - Source: layout plan of China coastal ports

Layout of Pearl River Delta port group

Figure 4 - Source: map of China main ports

5. Southwest Coast port group

Southwest Coast port group, consisting of coastal ports in western Guangdong, Guangxi and Hainan, mainly includes Beibu Gulf Port in Guangxi and Haikou Port in Hainan. It serves areas in western China and provides transport support for Hainan province in expanding material exchanges with places outside the island. The layout of Southwest Coast port group is shown in Table 8.

Layout of Southwest Coast port group

Port group	Core ports in the layout	Local ports or feeder ports	Port function	Scope of service
Southwest Coast port group	Zhanjiang Port, Fangcheng Port and Haikou Port	Including Beihai Port, Qinzhou Port, Yangpu Port and Sanya Port	Container	West China areas and Hainan province
	Zhanjiang Port, Haikou Port, Yangpu Port and coastal ports in Guangxi	-	Transit, storage and transport of petroleum and natural gas	
	Zhanjiang Port, Fangcheng Port and Basuo Port	-	Transit and transport of ore	
	Zhanjiang Port and Fangcheng Port	-	Transit, storage and transport of grain	
	Zhanjiang Port, Haikou Port and Sanya Port	-	Transit and cruise transport for domestic and foreign passengers	

Table 8 - Source: layout plan of China coastal ports

Layout of Southwest Coast port group

Figure 5 - Source: map of China main ports

Development of ports and terminals for different cargo categories

Development of coastal container ports

China's coastal ports have basically formed the port layout at various levels with eight ports of Dalian, Tianjin, Qingdao, Shanghai, Ningbo, Xiamen, Shenzhen and Guangzhou as container main ports, and other ports as local ports and feeder ports.

In 2015, another 12 container berths, including nine deep water berths, with a capacity of 6.15 million TEUs at coastal container terminals were built in China, and the number of multipurpose berths was reduced by three after contraction and renovation, resulting in an additional increase of container terminal capacity by 190,000 TEUs. By the end of 2015, China's coastal ports owned 394 specialized container berths, including 355 berths for ocean ships, with a throughput capacity of 183 million TEUs. In addition, China's coastal ports still had 150 multipurpose berths with a throughput capacity of about 10 million TEUs.2

Development of bulk cargo terminals

In terms of coal terminal construction, the construction layout of China's coal terminals always follows a pattern of shipping coal from North China to South China. By the end of 2015, seven coal-loading coastal ports in North China, namely Qinhuadao, Tangshan, Tianjin, Huanghua, Qingdao, Rizhao and Lianyungang ports, possessed 61 specialized coal-loading berths with a total coal-loading capacity of 820 million tons. There were 182 coal-unloading berths in China, including 147 deep water berths, with a total coal-receiving and unloading capacity of 700 million tons.

In terms of iron ore terminal construction, the layout of foreign-trade iron ore receiving and unloading ports in Bohai Rim had been formed with eight ports, namely Dalian, Yingkou, Tangshan, Tianjin, Yantai, Qingdao, Rizhao and Lianyungang ports, as principal ports, and three ports, namely Dandong, Qinhuangdao and Jinzhou ports, as supplement ports. The port layout for foreign-trade iron ore shipping system in Yangtze River Delta, which consisted of Ningbo-Zhoushan Port and those along the Yangtze River such as Shanghai, Nanjing, Zhenjiang, Nantong and Suzhou ports, had been established. The iron ore receiving and unloading coastal ports in South China mainly involve four ports, namely Zhanjiang, Fangcheng, Zhuhai and Fuzhou ports.

[2] Shanqing, Z. & Jianxin, C. (2006). *Summary of Coastal Port Construction in 2015* [J], China Ports. 2006(5).

By the end of 2015, China's coastal ports owned 60 iron ore receiving and unloading berths with a one-time iron ore receiving and unloading capacity of 100,000 tons and above per berth, and a total iron ore receiving and unloading capacity of 750 million tons.

Development of crude oil terminals

By the end of 2015, a two-tiered pattern of crude oil receiving and unloading ports had been formed in Bohai Rim. The six Tier-1 ports were Dalian, Yingkou, Tangshan, Tianjin, Qingdao and Rizhao ports, which mainly receive and unload crude oil directly from large oil tankers, and Tier-2 ports included Jinzhou, Qinhuangdao, Huanghua, Laizhou, Dongying and Longkou ports, which can transship crude oil from large ports and undertake offshore and ocean crude oil shipping tasks. The crude oil transit shipping system had been established in Yangtze River Delta with Ningbo and Zhoushan ports, located to the south of the Yangtze River estuary, being principal ports, and other ports including Shanghai, Taizhou and Nanjing ports being supplement ports. The rational layout of foreign-trade crude oil receiving and unloading ports has basically be set up along the coast of South China, including Quanzhou, Huizhou, Maoming, Zhanjiang, Qinzhou and Yangpu ports. By the end of 2015, China's coastal ports owned 27 berths with a crude oil receiving and unloading capacity of 200,000 tons and above each, and a total receiving and unloading capacity of 420 million tons.3

Development of China's port infrastructure construction

The planning, construction and operation of China's coastal port are currently in a good position, which is indicated by a healthy, stable and constant development trend. The port construction and operation have passed into the stage of adjustment and development according to the change of market demand. China's coastal port development has shown following trends.

I. Development of port infrastructure construction will be stable in the medium and long terms

On the one hand, amid constantly sluggish economy and trade, the port throughput growth rate constantly slows down.

[3] *Idem.*

With the increasing number of terminals and port's scientific and technological levels, terminal capacity and efficiency also go up, leading to the relative oversupply of terminal capacity. According to relevant information, the overall throughput adaptability at China's coastal ports has increased to 1.3, reaching the bottom line of throughput oversupply. At the same time, with a constant adjustment of transportation structures, the investment volume in coastal port construction has declined year by year. On the other hand, the infrastructure construction in China's five coastal port groups has been generally completed, forming a basically stable pattern, which means that it is not possible for China's ports to start large-scale construction of terminals and berths. In general, China's coastal port development will be stable in the medium and long terms

II. Different types of terminals have different development focuses

1. Because of the imbalanced development in crude oil terminal capacity, China will strengthen crude oil terminal construction in the future. According to the statistics, China had a crude oil terminal capacity shortage of 74.4 million tons in 2014, the largest since 2011. Although the shortage of crude oil-receiving and unloading capacity was somewhat eased with the successive operation of newly-built crude oil terminals and the construction of land channels, the throughput capacity of crude oil terminals was generally not enough. The imbalanced regional development led to the imbalanced crude oil terminal capacity. For example, in addition to Ningbo-Zhoushan Port, Dalian Port and Zhanjiang Port are the two ports with the surplus capacity of over 10 million tons each, while there is a crude oil terminal capacity shortage at Rizhao Port, Quanzhou Port and Huizhou Port. According to the crude oil terminal construction status in 2016 (see Table 3), Huizhou Port and Rizhao Port have strengthened their crude oil terminal construction, which will somewhat ease their terminal capacity shortage, but the shortage problem remains unsolved. It is estimated that crude oil terminal construction will be strengthened in the future.
2. There is an excess iron ore terminal capacity in North China and a capacity shortage in South China. Currently, 91 percent of China's ore berths with a capacity of over 100,000 tons each are distributed in Bohai Rim and Yangtze River Delta. There are 11 ore berths with a capacity of 300,000 tons and above per berth in Bohai Rim, accounting for 73 percent of those in China. To compete for cargo sources regardless of shipping-route water depth, the collection, distribution and transportation conditions, and the hinterland iron-ore demands, some ports in North China blindly elevated their ore terminal

capacities with designed throughput being much higher than the actual one, causing waste of resources and vicious competition. The maximum berthing capacity among the ore terminals along the coast of South China is maintained at the level of 200,000 tons, surfacing apparently insufficient berths, which is not conducive to achieving the long-term goal of iron ore receiving, unloading and transport. At the same time, according to China's iron and steel industry development policy, the steel materials demand-supply imbalance along the coast of Southeast China should be changed through the constant promotion of the construction of iron and steel bases along the coast of Southeast China and accelerated construction of coastal high-quality iron and steel product bases in Ningde, Zhanjiang and Fangcheng ports. With the shift of iron and steel enterprises to coastal areas in South China, the iron ore demand in South China will greatly increase. As a result, the focus of ore terminal construction will also shift to coastal areas in Southeast China.

III. Port transformation and upgrading will be the focus of port construction

1. Large-size ships have become the trend of shipping development, which has new requirements for port infrastructure. First, port's berthing, receiving and unloading capabilities should meet the requirements for large ships. Ports should offer better deep water conditions for large ships. For example, a fully-loaded 18,000-TEU ship requires the water depth to be at least 16 meters for waterways and ports. However, not many ports in China can meet this requirement. It is necessary to further dredge waterways and ports as well as renovate and upgrade ports' loading/unloading equipment in order to meet the requirement for ultra large ships. Second, the port's collection, distribution and transportation capabilities should be upgraded in order to meet the requirements of large ships. To avoid port congestion, it is necessary not only to upgrade ports' throughput capacity and storage yard capacity in the collection, distribution and transportation system, but also to achieve highly-efficient collaboration by coordinating various operation systems. It is necessary for trunk ports to constantly upgrade their hardware facilities in the future development, because meeting the requirements of large ships' berthing operation will be the focus of port construction in the future.
2. Against the global energy crisis and constantly worsening environment, green port development has become a new trend for achieving sustainable development of ports. Compared with the advanced western countries, China's green port construction apparently lags behind, and its green-port theoretical

research and practical exploration are still at the preliminary and developing stage. The main reasons include: first, China has more old ports which have been used for a long time, the port construction ideas and management methods lag behind in the port area development, the fund is insufficient and the environmentally friendly equipment are not complete; second, most ports have no comprehensive understanding of green ports. With the successive requirements from the central and local governments in China for the green port construction, the green construction will be the focus in the process of port upgrading and renovation.

3. Pilot work on building automated and intelligent terminals will be gradually carried out. According to the Action Plan on Promoting Intelligent Transportation Development (2017 - 2020), which was recently issued by the MOT, the intelligent port construction will become the focus in water transport's intelligent development. In an era when science and technology develop fast, the intelligent and unmanned terminal operation is the trend in the world's port development. It is estimated that an automated terminal can reduce manpower costs by about 70 percent and increase the operation efficiency by about 30 percent. China's port construction is currently in the stable development stage. Increased operation efficiency will greatly upgrade port's core competitiveness. Enhancement of intelligent and automated port construction will be the trend in China's port development. However, due to demanding investments and requirements for equipment and personnel, the automated terminal construction is currently in trial, and some ports with mature conditions have tried to build automated terminals. The automated terminal construction will be further promoted after relevant conditions mature.

Concluding remarks

The general pattern of China's port construction has been basically formed. With the descending global economy and the new normal of China's medium and high speed economic growth, China's coastal port will also enter stable development after experiencing the fast-growing port construction. Its port construction will grow steadily in the medium and long terms, the construction focus will be shifted to port's transformation and upgrading, and the moderate construction ahead of the times will be put under control. In terms of port transformation and upgrading,

China’s port and terminal construction should develop to get adapted to large ships, green, automation and intelligence. At the same time, problems including imbalanced regional development, redundant construction and disordered competition in China’s coastal port construction will be eased through the promotion of measures such as supply-side reform and port resource integration. In general, China’s port infrastructure construction will develop towards the healthy and stable direction under the state’s arrangement and guidance.

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