Main Scale Study on the Control of Navigable Ships in the Six Lei Tang Channel

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Abstract

To reduce the hidden danger of maritime security and improve the efficiency of inland navigation. Through the analysis of six Lei Tang (Huangpu ~ lotus road bridge segment) navigation environment, features, characteristics and the results show that the traffic flow channel within the ship scale almost all exceed class VII restricted channel corresponding to the representative type of scale; gate outside of ship captain 38m, a total length of not less than 37m about ship 50% of the total; the gate section of ship captain 34m, more than 50% of the total length of the ship were more than 34m. According to the relevant regulations, the main scale of Navigable Ship control is proposed and revised according to the actual situation. Through analysis, the proposed main parameters of navigable ships can effectively reduce the probability of occurrence of all kinds of water hazards, and make a reasonable consideration of the demand for water transportation along the river and the safety needs of ship navigation.

Keywords

Six Lei Tang channel; Traffic Flow; Ship Main Scale.

1. Introduction

In recent years, with the development of inland shipping and the continuous and rapid growth of inland transportation demand, inland shipping is moving toward large-scale, standardized, specialized and diversified modes of transportation. The large-scale ship is the inevitable embodiment and inevitable trend of the Environmental Protection advantage of inland shipping economy. [1]However, due to the limitations of the infrastructure of inland waterways, while increasing the efficiency of transportation and reducing the energy consumption per unit, the large-scale ship has also greatly increased the hidden dangers of maritime safety and the difficulty of shipping management.

Considering that the development level of inland waterway planning and construction has been difficult for some time to keep pace with the trend of large-scale development of ships, and that this situation will still exist for a certain period of time, in order to make full use of existing inland waterway resources, further reduce potential maritime security risks, and facilitate inland navigation management, Entrusted by the local maritime Department of minhang district, it plans to carry out the research on the main scale of navigation vessel control in liuretang(Huangpu river ~ liannan road bridge section) in minhang district. [2]

2. Navigational Environment

2.1 Natural Environment

2.1.1 Meteorology

Minhang District is a subtropical marine monsoon climate with a mild climate, four distinct seasons, moderate rainfall, more sunshine, and a long frost-free period. [3] The average annual temperature is 15.5 °C, the average temperature in January is about 3.1 °C, and the average temperature in summer August is about 27.8 °C. The rainfall is abundant and the precipitation season is obvious, but it is unevenly distributed. The average annual precipitation is 1114.7 mm, and the average annual rain day is 133.6 days, concentrated in Xiaqiujijie. The total amount of rainfall in the flood season accounts

for more than 60 years of the year, and the probability of rainstorm disasters is high. Catastrophic weather is mainly tropical cyclones, tornadoes, heavy rain and so on.

2.1.2 Fog situation

In the Shanghai area, there are more fog days in winter, the least in midday and summer, and the most in the middle of the day from midnight to sunrise. Most of them appear in radiation fog and disappear before 10 a.m., which has a greater impact on navigation safety; The average annual number of fog days is 28 days, and the maximum number of fog days is 53 days.

According to the statistical analysis of the facts and data of the fog day of the station in Minhang District, Shanghai from 1998 to 2007, the number of fog days after 2002(all below 10 days) in Minhang District showed a decrease compared to 2002(all over 18 days). trend; Night to morning is a time of fog; Winter fog is the most, followed by spring and autumn, and summer fog appears at least. [4]Visibility occurs in ordinary fog from 500 to 1000M, and the number of strong fog days is less than that of the surrounding districts.

The relative humidity at the time of fog is relatively high, of which more than 90 % of the fog is more than 80 % when it is fog, and the relative humidity is greater than 90 % of the fog day. When the fog appears, the wind speed is relatively small, basically below 3.0 m/s, and the wind speed is less than 2.0 m/s when the vast majority of fog appears.

In addition, static winds account for the largest proportion when fog appears, followed by Easterly and westerly winds. The probability of fogging when blowing southerly and northerly winds is minimal. In particular, there was no case of SSW and NNE winds in the fog day data in Minhang District for the past 10 years. When the fog appeared, the relative humidity was basically larger and the wind speed was smaller than 24 hours ago, and there was no obvious regularity in the change of air pressure and temperature.

2.1.3 Sediment

The Liuretang Waterway(Huangpu River ~ Liupujing(Songjiang District Boundary)) is located in the plain river network area. There are Liuretang sluice and Liuletang sluice in the upstream and downstream respectively. It belongs to the gate section, and the Liuletang sluice is drained daily. There is less sediment brought into the project by the tide. In addition, the water flow in the channel is gentle, the flow is stable, and the riverbed is stable. [5]There is no obvious change in riverbed erosion and siltation. In addition, the area where the flight section is located is flat, the vegetation coverage rate is high, the rainfall is weak on the surface, and there are few sediment sources entering the fairway. [6]According to the investigation, the overall dredging strength of the internal section of the Liuretang fairway was less than 0.03 M/A in the previous year, and the annual dredging strength of the outer section was less than 0.5m/a.

2.2 Course and Stream Density

According to the data, during the statistical period(349 days in total), a total of 6,935 ships entered the port of the Liuretang Channel and 6,702 ships departed from the port, and the average daily number of navigable ships was about 20 in one direction; Among them, the number of ships entering and exiting Hong Kong in February was the lowest, with an average daily average of about 8 ships; The number of ships entering and exiting the port in December was the highest, with an average of about 29 ships per day; The maximum number of ships entering Hong Kong on a single day is 41, and the maximum number of ships departing from Hong Kong is 38(all on December 13, 2014).

According to the analysis, the total number of ships sailing in and out of the Liuletang Channel during the year is basically the same, and the monthly distribution trend of the number of ships entering and leaving the port is basically the same and they are all undulating(the standard deviation is 6.22 and 6.08 ships, respectively). [7]The average daily traffic volume of navigable ships is low(the average is 20 times).

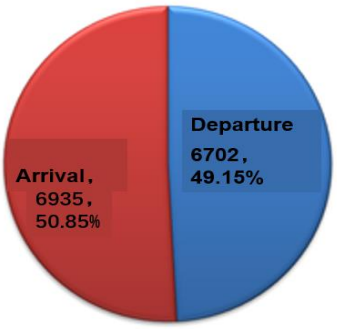

Fig. 1 Total and corresponding proportion distribution of navigable vessels in and out of port

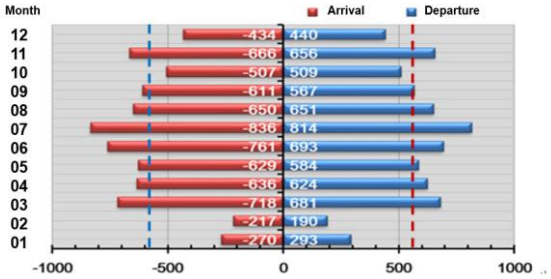

Fig. 2 Monthly distribution of navigation vessels entering and leaving port

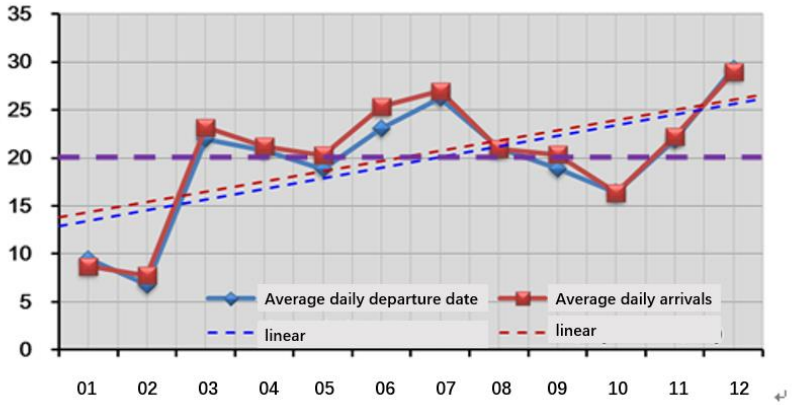

Fig. 3 Monthly distribution of the average number of ships entering and leaving the port

2.3 Navigation security

The inner wharves of the Liuretang Channel(Huangpu River ~ Lotus South Road Bridge Section) are more and closer, cross-channel bridges and pipelines are more and lower, and navigation ships hit bridges and scrapes across river pipelines are the highest probability of occurrence. [8] One of the dangers on the water, It is easy to produce secondary disasters with great impact when the overpass high pressure line and natural gas pipeline are in distress.

According to the investigation, under the active efforts of the local maritime department(air management office) and various relevant departments in minhang district, there have been fewer water accidents on the liuretang channel in recent years and they have been declining year by year. There are mainly the following two cases.

At 10:30 on September 27, 2011, at the time of the early high tide of the first day of the Lunar New Year, when the maritime personnel of the Chunshen Maritime Institute routinely cruised on the Liuretang Channel, they discovered that the 4001 ship of Ganji'an was out of control and was most likely to hit the gas pipeline on both sides of the Chegou Bridge. The dangerous situation, After contacting the relevant departments such as fire protection and public security water affairs, the danger situation was eliminated after emergency joint rescue. At 14:00 in the afternoon, the tide turned into a ebb tide, and the 4001 ship of Ji'an cargo appeared right-leaning and had shipwreck danger; After receiving the maritime notification, the salvage ship was unable to enter the scene in

time because of the large number of cross-channel pipelines and the low level, and the ship sank at 15:30. At 17 o'clock, the salvage ship had the conditions to enter the field and began to salvage. At 23 o'clock, the salvage ended and led to the Liuleitang Channel at 7 o'clock the next day.

At 16:15 on June 7, 2013, Zhehuzhou Cargo 2081 unloaded the bucket of cement from the dock of the Shanghai No. 2 Component Factory and returned. When passing through the pipeline bridge at 150m west of the Liuleitang sluice, the empty barrel of the ship resisted the pipeline bridge. [9] [10] The pipeline bridge steel plate was dislocated. Since the cable in the pipeline bridge is a high-voltage line, in order to ensure safety, the ship remains in place before the professional arrives, and the fairway is once cut off. After the joint rescue of nine departments such as Minhang Maritime, the depositioning steel plate was reset and the navigation channel resumed.

2.4 Summary

After investigation and analysis, although dredged, the current conditions of the Liuretang waterway are poor in width, bottom width, bending radius, and water depth. The terminal from the estuary to the Lianhua South Road bridge is densely populated, and the cross-channel bridges and pipelines are dense and low; The navigation ship's navigation law is concise and the density of the ship's flow is low. However, the navigation ship's scale is relatively large and it seriously exceeds the safe navigation range of the fairway. Some sections of the voyage are prone to dangerous situations such as hitting bridges or scraping across the river pipeline. It is difficult to launch water rescue in time due to navigation conditions. There are many industrial and residential buildings along the river along the two sides of the waterway, and it is more difficult to rectify and widen the waterways.

3. Current Status and Development Trend of Cargo Traffic on Waterway

3.1 Status of shipping routes

The technology of Liuleitang Channel(Minhang Section) is rated as VII, and the status quo is equal to that of the outer level; There are 28 terminals along the fairway, and the main loading and unloading species are building materials and cement. According to the statistics of the Minhang Local Marine Department, in recent years, the cargo volume statistics of the Liuleitang Waterway(Minhang Section) are shown in the table below.

year	Number of flights in and out(ship)	Cargo traffic (t)
2012	7,683	992,467
2013	9,533	1,114,752
2014	14,262	1,612,575

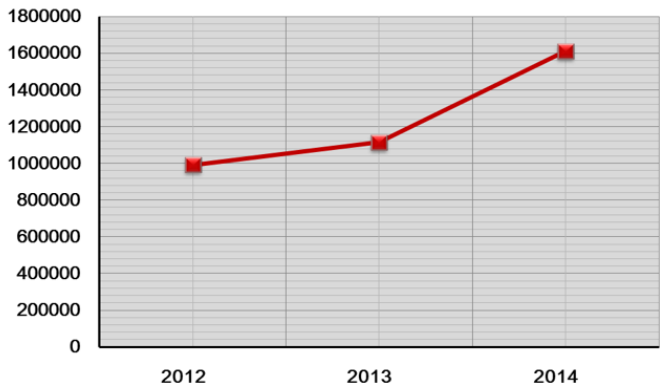

Fig. 4 Map of cargo volume of Liuleitang Channel (Minhang Section)(Unit: T)

From the cargo volume data of the Liuleitang Channel(Minhang Section), it can be seen that the cargo volume of the Liuleitang Channel has maintained a steady growth trend in the past two years, with an average annual increase of about 27 %.

3.2 Trends in Cargo Transport at Liuretang Waterway

During the 11th Five-Year Plan period, with the rapid economic and social development and the continuous improvement of urbanization in Shanghai, the construction of various infrastructure facilities was accelerated, and the water volume of inland rivers continued to grow, with an average annual increase of 2.4 % during the 11th Five-Year Plan period. During the 12th Five-Year Plan period, the volume of inland water traffic continued to grow steadily compared with the 11th Five-Year Plan period, reaching 183 million tons in 2012, and the volume of inland water traffic in 2013 was slightly lower than in 2012. In the first three years of the 12th Five-Year Plan period, the volume of inland water traffic in this city remained relatively stable.

At present, the volume of inland water freight in Shanghai is still dominated by the transportation of large quantities of coal, steel, mining materials, cement, etc. [11] At the same time, Inland river transportation plays an indispensable role in the transit of important goods related to the safe operation of urban systems such as grain, chemical dangerous goods, and urban garbage.

With the development of Shanghai's national economy, the construction of urban infrastructure and the economic and social development of the Yangtze river Delta, it will become a new growth point of inland water transport in Shanghai. According to the report's forecast of Shanghai's inland water traffic volume, Shanghai's inland water traffic volume will reach 225.25 million tons and 230.55 million tons by 2020 and 2030, respectively. [12]The average growth rate from 2010 to 2020 will be 3 %. The average growth rate will slow from 2020 to 2030, which will be about 0.2 %.

4. Analysis of Control Master Scale of Navigational Ships

4.1 Scope of scale control of navigable ships

Combining the relevant plans on both sides of the Liuretang waterway, the current situation and distribution of Linhe port facilities and water Conservancy hubs in the waterway, the cross-channel bridge pipelines, and the parameters of the current status of the waterway. It was determined that the scale control range of navigable ships in this study was Liuretang Channel(Huangpu River ~ Lotus South Road Bridge Section). According to the channel and water level conditions, the control scale of navigation vessels was studied in the section of Huangpu River ~ Liuletang sluice, Liuletang sluice ~ Lianhua South Road bridge.

4.2 Regional analysis of navigation bottlenecks

The channel scale is closely related to the economic benefits of inland river transportation and directly affects the navigation ability of the channel. The ship's avoidance, roundabout, braking, navigation and other behaviors all require certain channel conditions, including channel water depth, channel width, net height of navigation across the river and bending radius. These factors constitute the necessary conditions for the navigation of the ship. If the conditions are not available, the ship can not be navigable or navigable.

4.3 Master Scale Analysis for Control of Navigational Ships

The navigation condition of Liuretang channel is limited seriously, and it can not be effectively improved by implementing channel regulation and widening in the short term. In order to further reduce the various navigation safety problems caused by the large-scale navigation of the riverine industrial enterprises on the basis of meeting the demand of inland water transport, the main scale parameters such as the total length, width, and full load of navigable ships should be controlled according to the characteristics of the navigation bottleneck area.

Based on the main control scale of navigation vessels in the off-gate and in-gate sections, the main control scale of navigation vessels in the off-gate and in-gate sections is drawn as follows.

According to the main control scale of navigable ships proposed in this report, there will be ships that will account for about 92 % of the total number of unnavigable ships and about 80 % of the total number of unnavigable ships. According to the entry and exit visa registration data provided by the Liuletang Visa Point of the Chunshen Management Station(Maritime Bureau)(January 1, 2014-

December 16, 2014), a total of 1,782 ships will be banned from navigation, accounting for approximately 13 % of the total number of navigable ships in the waterway. [13] If the number of navigable ships beyond the control scale is converted to the number of ships within the control scale according to the same total weight tonnage, the total number of navigable ships within 349 days will increase to 14700 to 15,000, and the average daily one-way flow density will be 21 to 22 ships. Compared with controlling the data before the main scale of navigable ships, the increase is not small, and the navigation habits of navigable ships have not been significantly changed. Therefore, the inland water transport needs of the riverine industrial enterprises of the Liuleitang Channel can be reasonably taken into account.

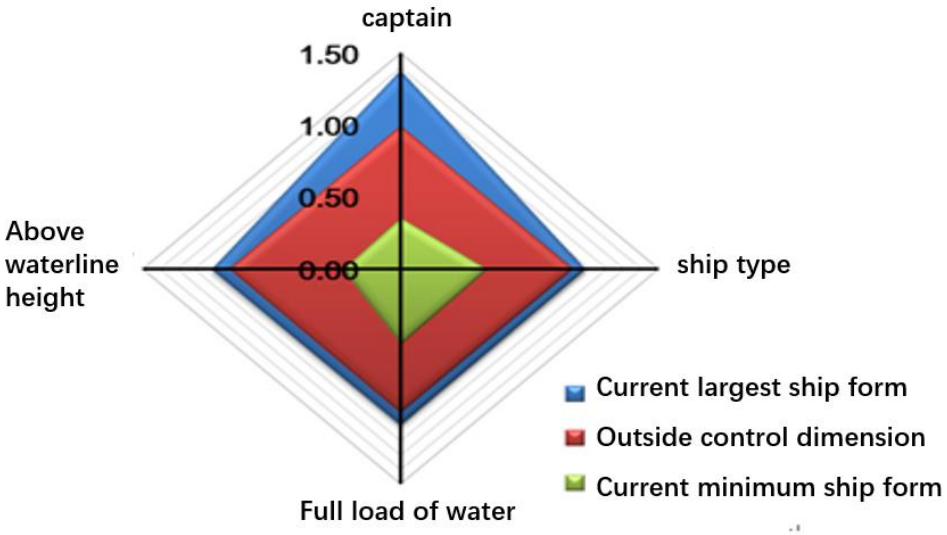

Fig. 5 Main dimensions and current situation of navigable ships in outer navigation section of ships

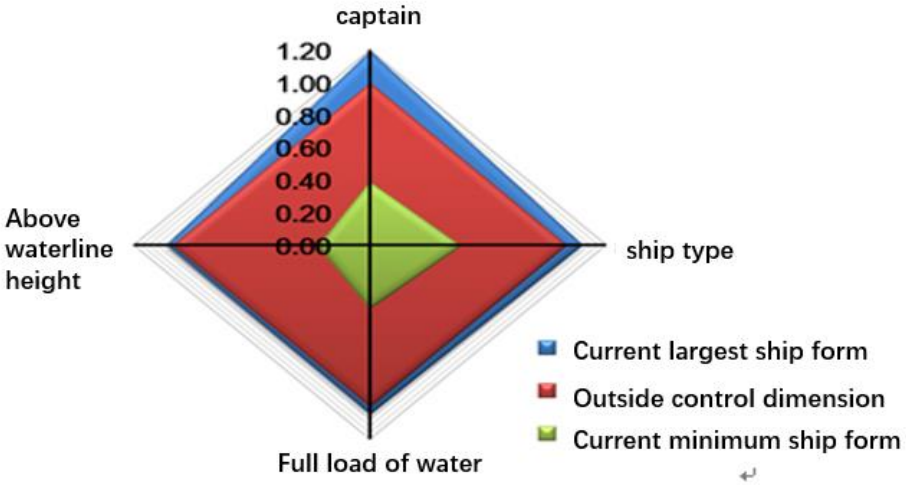

Fig. 6 Relationship between main dimensions and main ship size of ships in navigation section

4.4 Summary

Based on the screening and analysis of the navigation bottleneck waters outside and inside the gate of the Liuretang fairway, the corresponding requirements for controlling the main scale of the parameters such as the total length, width, full load draft and the height above the waterline of the navigable ship are proposed. Further amendments are made according to the channel conditions. Through analysis, the proposed parameters for controlling the main scale of navigation vessels can effectively reduce the probability of water hazards such as collision of cross-channel bridges or scraping of various types of pipelines across waterways, and the small increase in traffic density of navigation vessels under the condition of equal load tonnage has little impact. Can reasonably take

into account the demand of inland water transport and the safety demand of ship navigation of the industrial enterprises along the river along the Liuletang waterway

5. Traffic safety and security measures

5.1 Need for Traffic Safety and Security

The distribution of inland waterways in Minhang District is relatively obvious. According to geographical location, it is mainly distributed along the Huangpu River in Puxi and Pudong. The more busy waterways in Puxi District mainly include Dianpu River, Chunshen Pond and Liuleitang. In order to provide a safer navigation environment for navigable ships after the main scale control of navigable vessels in liuretang channel, corresponding supporting navigation safeguard measures should be added to facilitate identification and management.

The need to maintain order in navigation

There are currently 28 docks of various sizes in the Liuletang waterway, and there are about 100 cargo vessels that travel through the fairway all year round. Due to the poor navigation conditions of other fairways that are connected to the fairway, The current situation of the Liuretang Channel implements the navigation method of "East to East". The navigation conditions of the current channel are poor and the navigation conditions are relatively complicated. Therefore, it is necessary to adopt certain traffic safety guarantee measures to maintain the order of navigation in the fairway.

The need to secure navigation

There are 18 bridges, including 8 pipeline bridges, distributed from the Huangpu River Estuary to the Lotus South Road Bridge, which is about 4.4 km in length. Due to the different construction times, the bridge structure and navigation standards within the flight section are different, and it is difficult to meet the requirements of the current two-way navigation standards. In addition, the channel is tortuous and curved, the terminal is densely distributed, and the changeable navigation environment brings more navigation safety. hidden dangers, Therefore, it is necessary to set up the necessary navigation warning signs.

The Need of Digital and Scientific Management

The navigation characteristics of "East to East and east to the East" of the Liuleitang channel bring certain convenience to the digital and scientific management of the channel. According to the research results of this report, after the navigation channel is controlled on the main scale of the navigation vessel, it is necessary to control the ship entering and leaving the port on the main scale. [14] In order to facilitate the management's judgment, the digital management method can be used to store data on ships that meet the control requirements for multiple access to the navigation channel. It can simplify the process of entering and leaving Hong Kong and achieve fast and efficient visas.

5.2 Traffic Safety and Security Programme

For the six leyetang channel, which is controlled by the main standard of navigable ships, it should be equipped with appropriate traffic safety guarantee measures to form a comprehensive management system and reduce the hidden danger of navigation safety in the fairway. The traffic safety and security plan shall mainly include the laying of traffic safety signs, the adoption of measures for the maintenance of waterways, and the establishment of a scientific and efficient digital ship management system.

4.2.1 Emplacement of traffic safety signs

According to the contents of this report and the status quo of navigation, the establishment of fairway traffic safety signs mainly considers restricted scale signs, warning signs, and prohibition signs.

4.2.2 Waterway improvement measures

Maintenance dredging

According to the data of relevant departments, Liuletang carried out maintenance dredging in 2011. The dredging indicators were: dredging engineering channel excavation design bottom width of 8M

and 10m, local navigation section was limited to 6M due to river channel restrictions, and estuary width of 49m; The design floor elevation of the outer section of the gate and the Huangpu River estuary is -1.0 M, the inner section of the gate is -1.3 M, and the channel design slope is 1:2.5. Channel dredging has improved the navigation environment of the channel to a certain extent, which is conducive to the safe navigation of ships in the channel.

Waterway improvement

The Liuretang Waterway is a naturally formed fairway. Most of the two sides of the fairway are natural shore slopes. There has been no major rectification over the years. Therefore, a tortuous and curved fairway has been formed, and navigation conditions are poor. In particular, there are two reverse sharp bends with a turning radius of only 41 m from the estuary 2.0 ~ 2.4 km, which brings great hidden dangers to the navigation safety of ships and severely limits the navigation capacity of the fairway. Therefore, the channel regulation is a fundamental measure to improve the navigation environment of the channel. In particular, the bending and straightening of the sharp bend of the channel can effectively improve the navigation status of the channel and form a better navigation environment.

6. Summary

Through the investigation, analysis and forecast of the natural environment, navigation facilities, traffic environment, safety situation, related planning and traffic volume development of the Liuleitang fairway, the main scale of navigable ships is proposed for the outer and inner sections of the fairway. See the table below.

Table 1 List of Ship Control Master Scale of Liuretang Waterway

Channel name	Segment	General length	Ship width	Full load of water	Above waterline height
Six Lei Tong	Huangpu River - six Lei Tong sluice	42	7.0	2.3	3.0
Six Lei Tong	Six Lei Tong sluice - Lotus South Road Bridge	36	6.5	2.3	3.0

Through the analysis, the main control scale of navigable ships proposed in this study will help to further reduce the probability of water hazards such as collision of cross-channel bridges or scraping of cross-channel pipelines. Under the condition that the total load tonnage is equal, the new ship flow density after the implementation of the main scale control of navigable ships is relatively low, and it can reasonably take into account the inland water transport demand of the river industry enterprise of the Liuleitang Channel and the safety demand of navigation of ships.

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