

A Forestage Study on River Crossing
Passage across the Yangtze River Estuary

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I. An introduction

The Yangtze Delta region which is situated at the intersection of Yangtze River Economic strip and the coastal economic strip will, within the coming 10 years or a more longer period, present an entirely new appearance.

Communication is one of the important fundamental conditions for the economic development. Within recent years, the highway construction, the traffic enterprises in this region have gained an unprecedented development. It is, nevertheless, that the transportation of commuter movement, goods and materials as well as automobiles from the urban district in Shanghai to Chongming island and from Chongming to the northern part of Jiangsu Province still relies upon ferry boats or ships. The backwardness of traffic transportation enterprises not only suppresses the economic development in these areas, but also affects leap forward of the coastal economic strip.

Under the leadership of Shanghai Municipal Scientific Committee, the Shanghai Municipal Engineering Administration Bureau organizes relevant units to carry out the forstage study on the river crossing passage across the Yangtze River estuary. This paper will combine the research work and puts forward certain points of view for reference.

II. The necessity of building the Shanghai urban district ——Chongming——Nantong river crossing passage

1. The important composition of the north south coastal traffic corridor

Due to the interruption by the Yangtze River, it affects the intercourse between both banks of Yangtze River, meantime, it also makes the economic coordination and interchange which are not able to be fully developed between Nantong municipality etc. such regions in the north part of Jiangsu province with Shanghai and south part of Jiangsu province. As Shanghai is the foremost economic development head of the Yangtze River delta as well as the entire Yangtze River Basin, if a river crossing passage is built across the Yangtze River estuary, it will make Shanghai and Nantong as well as other regions in the north part of Jiangsu province be directly connected by means of highway transportation, as a result, it will of no doubt bring prosperity to the entire Yangtze River delta, meantime promote the economic development of the Yangtze River basin.

Building a Shanghai —— Chongming —— Nantong river crossing passage, and based upon this as a skeleton, connecting to the coastal highway network, composing into a "large north south traffic corridor", and connecting the China eastern coastal regions into a whole body, thus, it will enhance capability of developing and opening Pudong area as well as the radiating power of the economic development in the Yangtze River delta, resulted in the economic development of northern regions of Jiangsu province and the entire coastal regions. Meantime, the production base of agricultural product and by product in the north part of Jiangsu province, the energy resources superiority in north China, all these will give rise to the mutual supplementary purposes of the Shanghai economic development, as a result, it will make Shanghai ——such an international metropolis —— possess stronger competitive power in the international market.

2. Promoting the investment and development of 3 islands

(1) Superiority in the regional position

As Chongming, Changxing and Hengsha 3 islands which are situated at the Yangtze River estuary as well as at the midpoint of the long coast of our country connect to the bank along Yangtze River and to a broad hinterland, they are only more than 10km away from Pudong new zone. Shanghai Municipality will provide powerful economic, technical, informational, qualified personnel and policy support to the development of 3 islands. Though these regional position conditions are only potential factors now, it will, of no doubt, be the extension of developing and opening the Pudong new zone in the near future. The only problem lies in that if communication and other fundamental conditions are provided, the potential effect of the regional position will be activated.

(2) Superiority in resources

Chongming which is the third big island in our country has an area of 1,100 km², with a length of 76km in the east westward direction, and a width varying from 13-18km in the north southward direction, when the Changxing island and Hengsha island are combined with Chongming island, these are a total area of 1300km². The land resources which are the core of these 3 islands together with the harbour district, fresh water and living beings etc. will form a complete set of resources which will provide a good condition for development in future.

The length of the bank line of Chongming island is 209km, whereas, there is a 34km long relatively stable deep water bank line at the southern bank where it possesses good conditions for building harbour, and may develop into a

gathering and dispersing base for navigational transportation and the repair works of vessels.

(3) Environmental superiority

There are broad waters surrounding 3 islands, meantime the water in the island is clean, the earth is neat, the air is fresh, and the degree of mineralization of ground water is high. The Chongming island also possesses nearly 5000mu (1mu = 667M²) of park forest, and around 100,000 mu of reed marshes. Which will purify the environment of the island, currently these are nearly more than 2000 sorts of birds including swans, red crowned cranes dwell on this island. These natural scenery is also the ideal places to go vacationing or touring. The environmental superiority existed in these 3 islands will provide favorable conditions for the future development and opening.

In the coming 21st century, we shall build the 3 islands into a combination of international trade, gathering and dispersing commodities, high and new technique, processing for export, gong vacationing and touring etc. such an outward type, multipurpose and modernized prosperous island by means of fully utilizing the combined superiorities in the regional position, resources and environments existed in the Chongming, Changxing and Hengsha 3 islands, meantime, they will be backed by Shanghai etc. central cities, rely upon the scientific and technical progress, adjust their industrial structure and develop the outward type economy.

III. The geographical conditions of the Yangtze River estuary and dredging the waterways

Starting from Chongming island, the Yangtze River estuary is separated into northern and southern 2 tributaries. The southern tributary, farther on below the Wusong estuary, is further divided into a southern harbour and a northern harbour by the Changxing and Hengsha 2 islands, whereas the southern harbour is further separated into southern channel and northern channel (figure 1) by Jiuduansha.

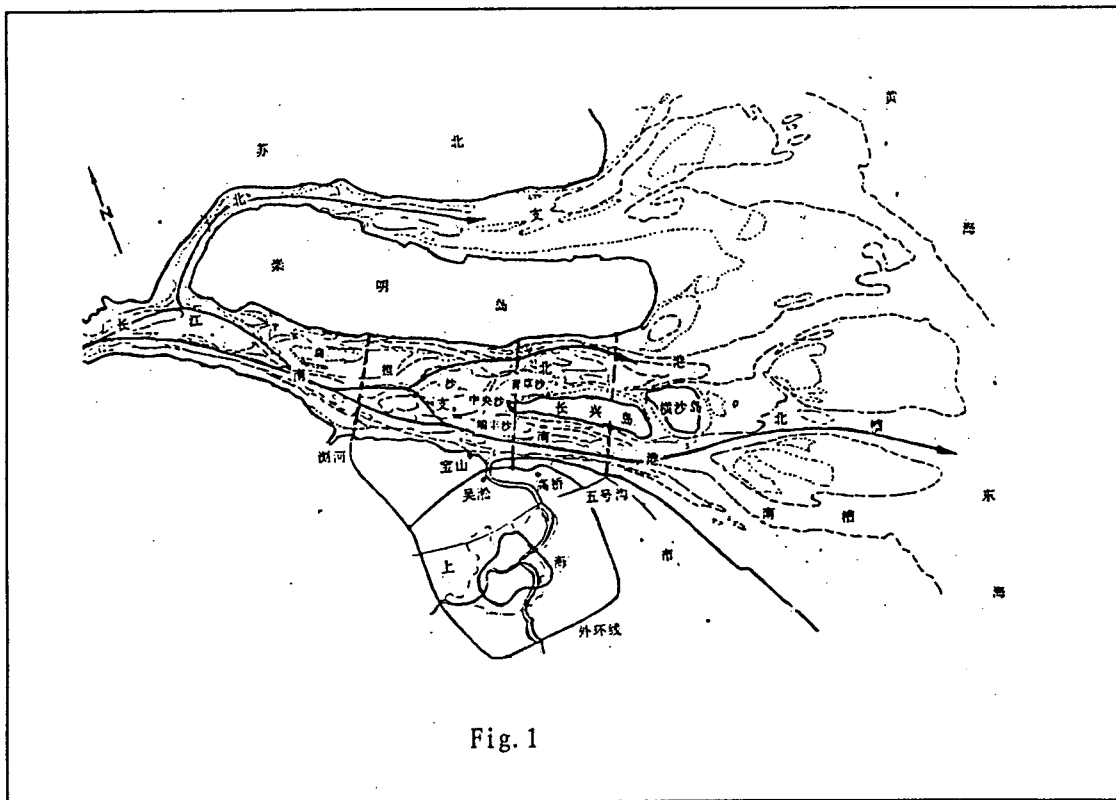


Fig. 1

The northern tributary whose total length is 78km is a passage linking Shanghai and water transport passage in the northern regions of the Jiangsu province. Due to the aggravation in the waterway, the navigational channel in the northern tributary is limited only from Chongtong to Jouxinggang, whereas the largest navigational vessel allowed is only about 300 tons, and the depth of draught does not exceed 2.8m.

The southern tributary which is the main water transport passage at the Yangtze River estuary has occurred 3 larger variation (changes) within the latest 30 years. The passage flowing to the sea was at southern channel of the southern harbour before 1984, and was changed to the northern channel of the southern harbour starting from 1984.

The northern channel is currently under dredging, with a purpose of maintaining a 7M water depth. The forward target will take measures by combining renovation and dredging together, in order to maintain a water depth of 12.5m for the navigational channel at northern channel, thus to enable the 3rd generation and 4th generation container ships may pass at all weather (or climate), and the bulk cargo ships of 100,000 tons may pass during high tide.

IV. Selecting sites, planning schemes for the river cross passage

The planned site for the river crossing project will be compared among 3 schemes as narrated below: (figure 2)

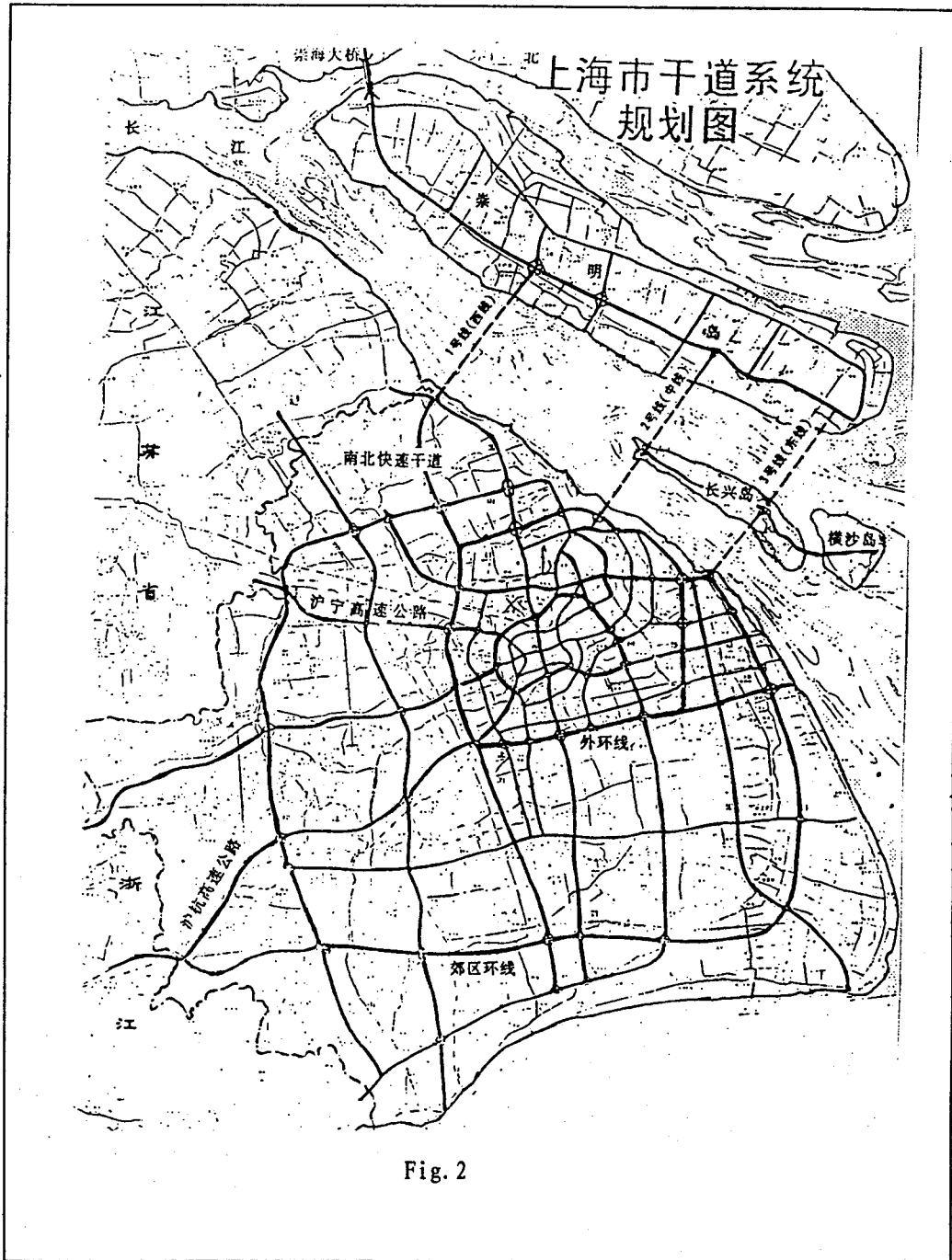


Fig. 2

1. Scheme 1:

The traffic at the southern bank of the Yangtze River will start from the intersection of Shanghai and Jiangsu province, and that on the Chongming island will start from east of the county, at a distance of 14.5km from the bank of Yangtze River. According to this scheme, it may directly connect with the north-south expressway trunk line and extend to Jinewer located at the northern bank of Hangzhou Bay, meantime, it may link with Shanghai urban outer ring (or loop) line an the suburban ring line. Go regards within the Chongming island, it may connect with the expressway in the central part and passing through Niupeng Gang bridge, extending forward to the northern part of Jiangsu province.

2. Scheme 2:

The traffic at the southern bank of the Yangtze River starts from the west of the Waigaojias harbour area which is at the east of the Wusong estuary, and then turning northward, passing through the west end of Changxing island and

further extending to the Chongming island. The river course is 7km away from the south of Changxing island, and 9.5km distant from the north of Changxing island, with a total length of 16.5km. According to this scheme, it may directly connect to the Pudong New Zone and also link with every district of Shanghai Municipality and the access road by means of outer ring line of Shanghai and the suburban ring line. As regards the Chongming island, it may connect with the expressway in the central part and passing through Niupeng Gang bridge and further extending forward to the northern part of Jiangsu Province.

3. Scheme 3

The highway at the southern bank of Yangtze River starts from the east side of No.5 Channel, Pudong, turning northward to the east end of Changxing island, through whose highway, driving westward, and after reaching the west end of the island, then crossing the Yangtze River again and reaching Chongming island, whereas the distance to the river surface is somewhat close to that of scheme2 whose roundabout way is comparatively longer, or an alternative may be considered by crossing the Yangtze River directly from the east end of Changxing island to the east terminal of Chongming island.

V . The technical feasibility regarding the passage of river crossing project

1. The main technical standard

The design speed: 80km/hr

The design load:

Computed by taking Qi(motor vehicle)

1 Chas (exceed) class 20, and checked by trailer-----20, special 300.

The width of the river crossing passage: Making analysis by taking situations of the Yangtze River delta and the coastal economic development as well as the traffic functions of the north south big trunk line, the width of the river crossing passage is specified as 6 lanes.

The navigational clearance for the bridge as well as the covering for the tunnel:

It is adequate to provide 2 main navigable spans at the main navigational channel of Yangtze River estuary. The design level at the bottom of the bridge girder is 61.3M . The navigable width of each main navigational channel shall not be less than 400M. Besides the main navigational channel, it is intended to reserve 2 secondary navigational channels whose net width is 120M, with a net clearance of 25M.

If shield method is employed for construction, then the thickness of covering for the tunnel shall, the minimum thickness from the lowest scouring line at the river bottom to the top of shield machine, not be less than the diameter of the shield machine; if immersed (or sunken) tube method is employed, then the thickness of the covering earth fill on the top of the immersed tube shall, counted according to the lowest scouring line, be larger than 2M.

2. The river crossing scheme by bridge

A viaduct whose span varies from 1200-1500M and type may select either a cable-staged bridge or a suspension one may be built on the main navigational channel at the Yangtze River estuary.

The northern harbour which is nearby the bank line of Chongming island needs to provide 2 secondary navigational spans on which 2 medium size bridges whose navigational clearance shall exceed 25M with a span greater than 150M will be built.

Viewing the river crossing bridges from the entire line, it is observed that most bridges are located at places where the navigable requirements are not as high, moreover, the level at the bottom of the bridge girder only needs some 10M above the water level, then it will meet the requirements.

Selection of type of bridge

A cable stayed bridge whose main span will be greater than 1200M will be built on the main navigational channel. It is, however, that currently there is no cable stayed bridge whose span is greater than 1000M in the world. Hence, there are a good deal of problems needed to be further studied regarding the design and construction of such a cable stayed bridge which will cross over the Yangtze River estuary.

The suspension bridge:

It will be a rational selection to adopt a suspension whose span is greater than 1200M, it is, however, that building the anchorage structure of such a suspension bridge on the soft and weak foundation at the Yangtze River estuary will be a comparatively difficult problem which will be the most fundamental topic to be researched on building the suspension bridge.

The medium size bridge whose span is 150M may employ a height of variable cross section, prestressed continuous box girder structure, meantime, the converting method for the longitudinal cantilever girder is also comparatively matured.

3. Tunnel

(1) Boring tunnel by shield method

The scale of river crossing tunnel at the Yangtze River estuary may set up 2 tubes containing 6 lanes, each tube contains 3 lanes in one way traffic. The outside diameter of the tunnel is 14.4M, and the inside one, 13 M.

The prefabricated high precision reinforced concrete segments which will form a circular ring will be adopted as the lining for the tunnel, meantime bolts will be used as the connection between the longitudinal joint and circumferential joint of the segments, moreover, neoprene rubber water swelling elastic rubber gasket will be installed between joints.

The construction of tunnel may be carried out either by pressurized slurry balanced shield machine or by earth pressure balanced shield machine. By means of employing such type of shield machine, it is capable of safely and reliably penetrating through the saturated, water bearing, soft and weak clay layer and sand layer beneath the river bottom. The design and manufacture of the shield machine whose outside diameter reaches as large as 14.64M may, on the basis of using the foreign advanced technique, be solved by means of further research work in order to ensure that a successively boring the tunnel shall be at least over 4KM once.

(2) Building the tunnel by immersed (or sunken) tube method

The layout of the cross section for a 6 lane immersed tube tunnel is composed of a rectangular cross section containing 3 tubes, 3 lanes will be installed respectively in the two side tubes, whereas the middle tube will be reserved for mounting equipment and used as the pipe duct. The width of a 3 lane immersed tube tunnel is 36.1M, with a height of 8.7M, and the design length for each immersed tube section is approximately 120M. The width, slope of the foundation trench, and measures against aggravation, meantime, limitations regarding the wind speed, height of wave and speed of water flow on the river surface etc. during sinking the tubes, all these shall have to make earnest study.

4. A scheme of combining bridge and tunnel together for river crossing

The advantage of combining bridge and tunnel together as a scheme for river crossing lies in that it may fully utilize the topography of the river bed, and carry out layout of bridges or tunnel in line with the practical local conditions. When the navigable regiments are not as high, the height from the bottom of the bridge girder to the water surface is about 10M, then the bridge scheme may be adopted, If the place is situated at the deep water navigational channel, then tunnel scheme may be used. If the tunnel scheme is adopted the connection for the bridge and tunnel may be achieved by building an artificial island which is generally built at the place where the water depth is around 2-5M, or at place where the ventilation shaft for the tunnel is installed .

(1) The preliminary envisage regarding the layout for bridge and tunnel

River crossing scheme 1:

The Biandansha lies across the river where the water depth is about 2M, with a width of 2.7Km, it is suitable to build an artificial island here. The scheme of layout for the river crossing project is: there is a 9.5Km long tunnel arranged in the southern side; and a 5.0Km long bridge arranged in the northern side. The bridge and tunnel will be connected by means of an artificial island.

River crossing scheme 2:

The Ruifengsha whose water depth is about 2M with a width of 1.5Km is located at the southern end of Changxing island, hence, a 4Km long tunnel may be arranged at the southern side of the main navigational channel site in the southern harbors, whereas at the northern side, a 3Km long bridge may be arranged. An artificial island will be built in the vicinity of Ruifengsha of connect the bridge and island .

From Changxing island to Chongming island, the main navigational channel is nearly the Chongming island, where the water depth at Qingcaosha is over 2M, with a width of about 4Km. Therefore, a bridge may be built at the southern side (near Changxing island) of the northern harbour, whereas at the northern side (near Chongming island) it is suitable to build tunnel. The bridge and tunnel may be connected by means of an artificial island built on the Qingcaosha.

River crossing schemes 3:

The width of river surface from the No.5 channel, Pudong to Changxing island is about 7km, most of the level at the river bottom is -10M. The deepest level is -14M. The spacing of -5M isobath is approximately 5.6M. According to the river crossing scheme, a 5Km long tunnel will be arranged at the southern side of this site, and will penetrate through under the main navigational channel of the southern harbour, then connect to the artificial island and further connect with the bridge at the northern side, and the length of bridge is 2Km. .

(2) The artificial island

The artificial island which is used to connect the bridge and tunnel will install a ventilation shaft for the tunnel as well as provide maintenance and administrative facilities for the river crossing traffic. In case possible, it may also furnish service facilities, to provide mess, rest and form for chauffeurs and passengers.

The width of the dyke top of the artificial island shall be better greater than 100M, and the length shall be better larger than 500M which will include the slopeway of tunnel and bridge, and a certain length of that (zero slope) road section. The value taken for level at the top of the dyke of the artificial island shall take consideration of the highest tide and the invasion of typhoon without and affection to the dyke.

VI. A preliminary comparison among the river crossing schemes

1. A comparison of touting scheme

(1) Scheme 1 (west line):

The contact between Shanghai and Chongming island is comparatively direct and quick, moreover, the length of the passage is the shortest. The traffic at the southern bank may directly connect with the south expressway trunk line, and link with Hulian, Huning, and Hulang freeway as well as connect to the Hugging 1st class highway, whereas the radial road traffic need not to pass through the urban district, The disadvantage lies in that the river channel at this section is not stable, and the variation caused by scouring and aggradation is very frequent .

(2) Scheme 2 (the middle line):

The contact between Pudong developing zone and Changxing, Chongming 2 islands is direct and quick, moreover, it is advantageous to take account of the development for both Changxing island and Hengsha island. The traffic at the southern bank may directly link with the northern and southern Pudong developing zone by means of outer ring line and Yanggao road, as regards going to Puxi (west of Huangpu river), it may be achieved by connecting with the outer ring line and suburban ring line etc. such expressways. The river channel at this section is relatively stable.

(3) Scheme 3 (east line):

The contact between the Pudong developing zone and Changxing island is convenient and quick, it is a advantageous to the development of Changxing and Hengsha two island. Go regards traffic, it may also connect with the outer ring line and the suburban ring line. But the water depth in the southern harbour is relatively deep, hence, it is comparatively difficult to build the artificial island and the ventilation shaft for the tunnel.

2. A comprehensive comparison for the river crossing project

(1) Traffic functions

All the bridge scheme, tunnel scheme, a combination of bridge and tunnel scheme will fulfill the requirement of the forward traffic development. A comparison between the bridge and tunnel two scheme, in the bridge scheme, the climb of the automobile will be somewhat 20M higher than that of the tunnel scheme; as regards a combination of bridge and tunnel scheme (tunnel plus low clearance bridge), the climb of the automobile lies between the bridge and tunnel scheme .

The misty days in the Yangtze river are over 50 days each year, and each time it last about 3 hours. During typhoon season in the summer, occasionally, there are wind of Beaufort force 8 (fresh gale) to Beaufort force 10 (severe gale) occurred. The temperature at January and February each year is comparatively low, hence freezing may easily be formed on the deck. In the above mentioned unfavorable weather, it will exert greatest affection to the traffic of the viaduct.

(2) The technical feasibility

The bridge and the tunnel scheme;

On the basis of using the international advanced technique for reference, carrying out detailed hydrological geological reconnaissance survey and execute fully the forestage stage test and study, we are confident to carry out the design and construction by ourselves, and are fully able to accomplish this project. The advantages of the tunnel scheme by employing shield driven method, with the exception of building ventilation shaft, lie in that it will not be affected by strong wind, rainy days, and waves etc. such unfavorable weather, moreover, there is no need to carry out jobs either above water or under deep water, hence it will not affect the navigation in the navigational channel.

(3) Affections to the navigational channel

Either the bridge scheme or the tunnel scheme by employing immersed tube method will bring certain affections to the navigational channel during construction period, but it may be solved through rational dispatch.

After completion of the river crossing project, the bridge scheme will no doubt give height limitation control, few ships whose mast height exceed the height limitations will not be able to pass the bridge and sail into the upper reaches.

(4) Management and administration

Under the strong wind, large mist, ice and snow etc. such unfavorable climatic conditions, it is necessary for the viaduct to execute blockade of traffic or limitation of traffic, on the contrary, the traffic in the tunnel will, under and climatic conditions, not be affected. In the bridge and tunnel combined scheme, the affections by the climatic conditions to the bridges of low navigational clearance is relatively small compared with that of a viaduct.

The tunnel needs to install lighting ventilation etc. which will be in an actuating state during day and night, hence the equipment and administrative charges are higher than those of a bridge. The main span of the bridge which will be over 1200M will be built of box girder made up of steel structures. As the bridge hangs in the sky above the Yangtze river, therefore the difficult of repair and maintenance for the guy-cable and the steel girder is comparatively larger.

VII. The conclusion words

The river crossing passage across the Yangtze River estuary is an important composition of the large north south traffic corridor along the coast. The construction of the river crossing project will be of important significance to the prosperity of Shanghai and opening of Pudong, to the development of Yangtze River delta, the economy along the coast, and to the investment and development of Chongming, Changxing and Hengsha 3 islands.

The river crossing project is a grand project going beyond the century, as the investment is large, the technique is complicated, moreover, the project is involved in a variety of aspects, hence the preparation time in the forestage is long. Therefore it is necessary to make research work and demonstration beforehand regarding key problems, such as making comparisons and selections of sites as planned for the 3 river crossing passages: the change of the river course,

engineering geology, hydrological conditions, the reconnaissance survey and investigation of the geomorphological aspects at the river bottom etc.; a special demonstration regarding the navigational clearance, the large span bridge and its foundation structure, the large diameter tunnel structure and its construction plants, the technical feasibility on building the artificial island and its affections to the river bed etc.; all these will furnish an all-sided and reliable basis for selecting the site of the river crossing project as well as making comparisons on the forms of river crossing;

We firmly believe: after the coming several years are passed, the river crossing passage across the Yangtze River will be accomplished, and it will be a main traffic trunk line from Shanghai to the northern part of Jiangsu province, and will be the important foundation conditions for developing and opening Chongming , Hengsha and Changxing 3 islands.

长江口越江通道前期研究

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一、概述

长江三角洲地区是长江经济带和沿海经济带的交汇处,在未来的十年或更长一段时间里,该地区的经济发展将会出现崭新的面貌。

交通是经济发展的重要基础条件之一。近几年来,该地域的公路建设、交通动输事业取得了前所未有的发展。但是上海市区至崇明,崇明至江苏北部仍靠轮船渡送客流、物资及汽车。交通动输事业的落后,不仅抑制这些地区的经济发展,而且影响沿海经济带的腾飞。

在上海市科委的领导下,上海市市政工程管理局组织有关单位进行了长江口越江通道前期研究。本文结合该研究提出一些观点,供参考。

二、建设上海市区——崇明——南通越江通道的必要性

1、沿海南北交通走廊的重要组成

由于长江的阻隔,影响了长江两岸的经济往来,苏北南通市等地区与上海以及苏南地区的经济协作及交流未能得到充分展开。上海是长江三角洲,乃至整个长江流域经济发展的龙头,建造长江口越江通道,可以使上海与南通及苏北其它地区直接通过公路运输相通,必将带动整个长江三角洲的繁荣,促进长江流域的经济发展。

建造上海——崇明——南通越江通道,并以此为骨架连接沿海公路网,组成“南北交通大走廊”,将中国东部沿海连成一体,从而增加了浦东开发、开放,长江三角洲经济发展的辐射力,推动苏北地区和整个东部沿海地区的经济发展。同时,苏北的农副业产品生产基地,华北的能源资源优势等,对上海的经济发展到互补作用,使上海这个国际大都市在国际市场上具有更强的竞争能力。

2、促进三岛的开发和发展

(1)区位优势

位于长江口的崇明、长兴、横沙三岛地处我国漫长海岸的中点,内通长江沿岸,腹地广阔;离浦东新区仅10余公里,上海市为三岛开发提供强有力的经济、技术、信息、人才、政策的依托。这些区位条件,目前尚为潜在,但不久将来必然是浦东开发开放的延伸,只要具备交通和其它基础条件,潜在的区位效应势将活化。

(2)资源优势

崇明是我国第三大岛,面积1100平方公里,东西长76公里,南北宽13--18公里,加上长兴、横沙二岛,总面积1300平方公里。三岛以土地资源为核心,有港域、淡水、生物等资源配套,对未来的开发具备良好条件。

崇明岛岸线长209公里,南岸有34公里长较稳定的深水岸线,具有建港的良好条件,可发展成为航运集散基地和船舶修造业。

(3)环境优势

三岛四周有广阔的水域,岛上水清、土净、空气新鲜,地下水矿化度高。崇明岛上还拥有5000亩森林公园,近10万亩芦苇荡,净化着岛上环境,目前已有包括天鹅、丹顶鹤在内的2000多种鸟类在此栖息,这些天然风光,也将是渡假、旅游的理想地方。三岛的环境优势为未来的开发、开放提供良好的条件。

在未来的21世纪,充分利用崇明、长江、横沙三岛的区位、资源、环境组合优势,依托上海中心城市,依靠科技进步,调整产业结构,发展外向经济,把三岛建成集国际贸易、物流集散、高新技术、出口加工、渡假

旅游的外向型、多功能、现代化的繁华岛屿。从这一战略目标来看,建设长江口越江通道工程是十分必要。

三、长江口地理条件及航道整治

长江口由崇明岛分隔为南、北两支。南支在吴淞口以下又被长兴、横沙两岛分隔为南港和北港。南港在九段沙再被分为南槽和北槽。(图 1)

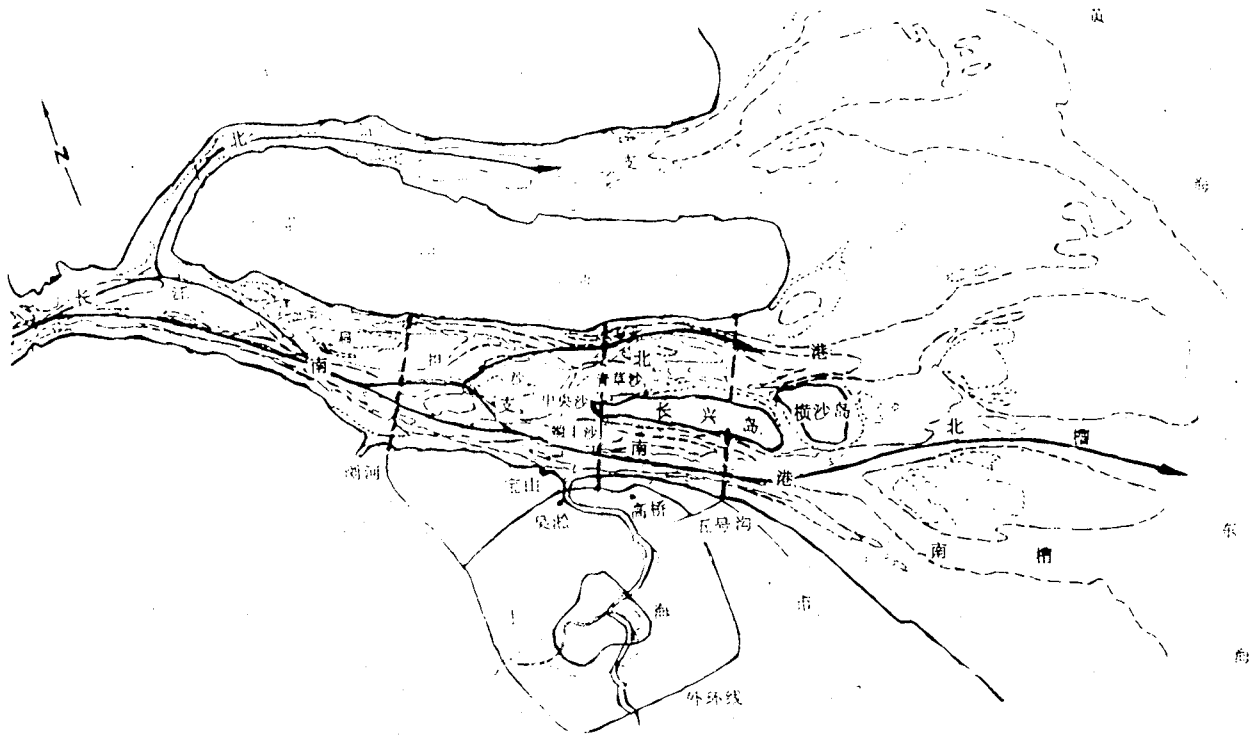


图 1 长江口平面位置图

北支全长 78 公里,是沟通上海和苏北的水运通道。由于河道淤积,目前北支航道限于崇头至头兴港河段,通航船只最大为 300 吨左右,吃水深度不超过 2.8 米。

南支是长江口的主要水运通道,近 30 年发生过三次较大变动,入海通道 1984 年以前为南港南槽,1984 年起改由南港北槽。

北槽目前靠疏浚,以维持—7.0 米水深。远期以整治和疏浚相结合的措施,使北槽航道水深达—12.5,能全天候通过第三代第四代集装箱船和乘潮通过 10 万吨级散货船。

四、越江通道的选址规划方案

规划的越江工程位置为由下述三个方案进行比较:(图 2)

1、方案一

长江南岸选在上海与江苏交界处,崇明岛上位置在县城以东,江面距离 14.5 公里。该方案可直接上南北快速干道至杭州湾北岸的金卫,并可连通上海城市外环线及郊区环线,崇明岛内可连接中部快速公路通过牛棚港大桥至苏北。

2、方案二

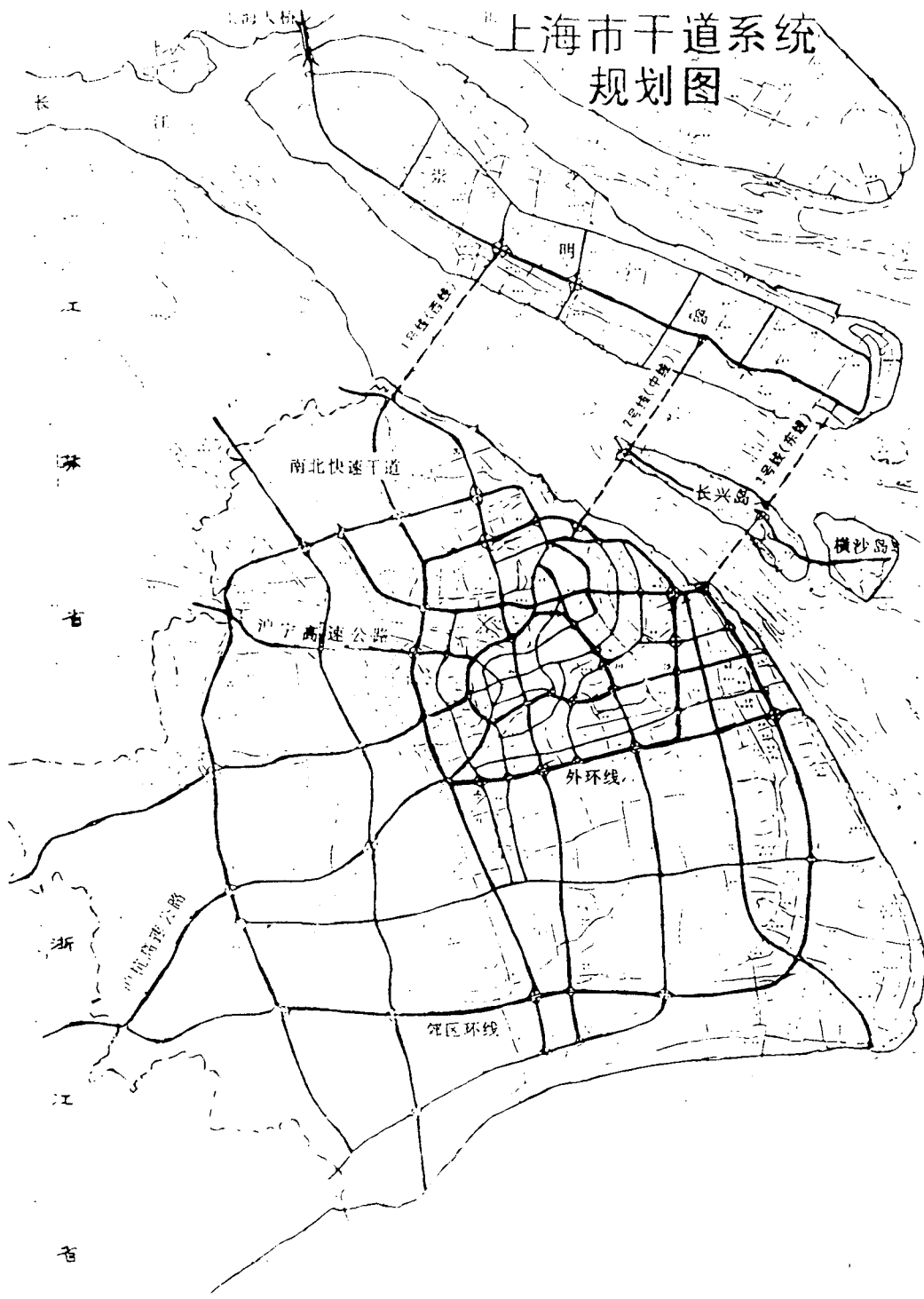


图 2

长江以南选在吴淞口以东外高桥港区以西,向北经过长江岛西端延伸至崇明岛。江面距离长兴岛以南 7 公里,长兴岛以北 9.5 公里,全长 16.5 公里。该方案直连浦东新区,并可通过外环线和郊区环线连接上海市各区和过境交通。崇明岛可接上中部快速公路通过牛棚港大桥至苏北。

3、方案三

长江南岸在浦东五号沟东侧,向北至长兴岛东端,经长兴岛内公路向西至岛西端后,再越江到崇明岛,江面距离与方案二接近。该方案绕行距离较长。从长兴岛东端直接越江至崇明岛东端,也可作为比较方案。

五、越江通道工程的技术可行性

1、主要技术标准

设计行车速度:80公里/小时。

设计荷载:以汽一超20级计算,以挂车一120、特一300验算。

越江通道宽度:从长江三角洲和沿海经济发展的态势和南北大通道交通功能分析,越江通道宽度为6车道。

桥梁通航净空及隧道覆盖层厚度:长江口主航道宜设二个主通航孔。桥梁梁底设计标高为61.3米。每一个主航道通航净宽不小于400米。除主航道外,拟留二个副航道,每个副航道的净宽为120米,净空为25米。

隧道覆盖层厚度,若采用盾构法施工,江底最低冲刷线距盾构顶部最小厚度拟不小于盾构的直径。若采用沉管法施工,沉管隧道上部的覆盖土厚度以最低冲刷线计,拟大于2米。

2、桥梁越江方案

(1)桥梁的分段和组成

长江口的通航主航道建一座跨度为1200-1500米的高架桥,高架桥桥型可选择斜拉桥或悬索桥。

北港靠近崇明岛岸线,需设二孔副航道,建二座通航净高为25米以上,跨度为150米以上的中桥。

从越江桥梁的全线来看,大部分位于通航要求不高,桥梁梁底标高高出水位10米左右就能满足要求。

(2)桥型选择

斜拉桥:主航道建造主跨大于1200米的斜拉桥。目前世界上跨径大于1000米的斜拉桥尚无前例,因此这一座跨越长江口的斜拉桥在设计和施工上都有很多问题需要进一步研究。

悬索桥:跨度大于1200米的桥梁,悬索桥将是一个合理的选择,但是在长江口软弱地基上建造悬索桥的锚碇结构将比较困难,这是建悬索桥最主要的研究课题。

跨度为150米的中桥可采用变截面高度的预应力连续箱梁结构,纵向悬臂浇筑施工方法也比较成熟。

3、隧道

(1)盾构法隧道

长江口越江隧道的规模可设为双管六车道,每管为单向三车道。隧道外径14.4米,内径13米。

隧道衬砌采用预制高精度钢筋混凝土管片组成圆环,管片之间的纵向和环向都用螺栓连接。接缝之间设置氯丁橡胶或复合遇水膨胀橡胶弹性衬垫。

隧道的施工,可采用泥水加压平衡盾构或土压平衡盾构。使用这一类型的盾构,能够安全、可靠地穿越江底饱和含水软弱粘土层和砂层。外径达14.64米的盾构,设计和制造,在借鉴国外先进技术的基础上,需要进一步研究解决,以确保一次连续推进4公里以上。

(2)沉管法隧道

六车道沉管隧道横断面布置由三孔组成矩形断面,两边孔各设三个车道,中间孔为设备及管廊。三孔沉管隧道宽度36.1米,高度8.7米。每节管段设计长度为120米左右。对基槽的宽度、坡度,防淤措施,管段沉埋时对江面风速、浪高、水流速度的限制等都要作认真研究。

4、桥、隧组合越江方案

桥、隧组合越江方案可充分利用河床地形,因地制宜布置桥梁或隧道。通航要求不高,梁底至水面高度10米左右,采用桥梁方案。深水航道位置可采用隧道方案。桥梁和隧道的联接可采用人工岛,人工岛一般设在水深2-5米处或设在隧道通风竖井处。

(1)桥、隧布置的初步设想

越江方案一:扁担沙横亘其中,水深约-2米,宽2.7公里,可设人工岛。越江工程布置方案南侧为隧

道长 9.5 公里;北侧为桥梁,长 5.0 公里。桥、隧道通过人工岛相联。

越江方案二:长兴岛南端的瑞丰沙深约为-2 米,宽 1.5 公里,因此南港的南侧主航道位置可布置 4.0 公里长隧道,北侧布置 3.0 公里长桥梁,在瑞丰沙附近设人工岛联接桥梁和隧道。

长兴岛至崇明,主航道靠近崇明,青草沙水深 2 米以上,宽度约 4 公里,因此北港南侧(靠长兴岛)可建桥梁,而北侧(靠崇明岛)宜建隧道,桥梁和隧道可由青草沙人工岛联接。

越江方案三:从浦东五号沟至长兴岛,江面宽 7 公里,江底标高大部分为-10 米,最深处为-14 米,-5 米等深线间距约 5.6 公里。该位置越江方案南侧布置隧道,长度 5 公里,穿越过南港主航道,然后接人工岛与北侧桥梁相联,桥梁长度 2 公里。

(2) 人工岛

人工岛联接桥梁和隧道,人工岛上设有隧道的通风竖井、越江交通的维修管理设施。如有可能也可设置服务设施,供司机、乘客用餐、休息和旅游。

人工岛的堤顶宽度宜大于 100 米,长度应包括隧道和桥梁的坡道,及一定长度的平坡路段,宜大于 500 米。人工岛的堤顶标高的取值应考虑最高潮位及台风侵入而不受到影响。

六、越江通道方案的初步比较

1、线路方案比较

(1)方案一(西线),上海市至崇明岛之间联系较为直捷,通道长度最短,南岸交通直接连接南北快速干道,并与沪嘉、沪宁、沪杭高速公路及沪青平一级公路相通,过境交通可不穿过市区。但该段河槽不稳定,冲淤变化频繁。

(2)方案二(中线),浦东开发区与长兴岛、崇明岛之间联系直捷,有利于兼顾长兴岛和横沙岛开发。南岸交通可通过外环线、杨高路等直通浦东开发区南北,至浦西可通过外环线和郊区环线等快速路联接。该段河槽比较稳定。

(3)方案三(东线),浦东开发区与长兴岛联系较为便捷,有利于长兴、横沙二岛开发。交通上也可联接外环线和郊区环线。但南港水深较深,人工岛和隧道风井的施工比较困难。

2、越江工程的综合比较

(1) 交通功能

桥梁方案、隧道方案、桥隧组合方案都能满足远期交通量发展的要求。

桥隧两方案相比,桥梁方案汽车爬高比隧道方案高 20 米左右,桥隧混合方案(隧道加低桥)汽车爬高介于桥梁和隧道方案之间。

长江口雾日每年 50 天以上,每次 3 小时左右。夏季台风期偶有 8-10 级。每年 1-2 月温度较低,桥面易产生冰冻。上述不良天气,对高架桥的交通影响最大。

(2) 技术可行性

桥梁和隧道方案,在借鉴国际先进技术的基础上,进行详细的水文地质勘测和充分的前期试验研究,依靠我国自行设计、自行施工,是完全有能力建成的。

采用盾构法施工的隧道方案除通风竖井外,不受大风、雨天、波浪等恶劣天气影响,不需要进行水上及深水作业、不影响航道通航。

(3) 对航道影响

桥梁方案、沉管法隧道方案在施工期间对航道都带来一定的影响,但通过合理调度都是可以解决的。越江工程建成以后,桥梁方案必然要进行限高控制,极少数桅杆高度超过限高的船只不能进入桥梁上游。

(4) 运营和管理

高架桥在大风、大雾、冰雪等恶劣气候条件下,需进行封锁交通或限制交通。隧道在任何气候条件下交通都不受影响。桥隧道混合方案中低桥受气候条件的影响比高架桥相对要小。

隧道需设置照明、通风等,白天、晚上都处在起动车状态,设备和管理的费用比桥梁高。

桥梁主跨为 1200 米以上的钢结构箱梁,在长江上空,拉索和钢梁的维修养护难度较大。

七、结语

长江口越江通道是沿海南北交通大走廊的重要组成,越江工程的建设,对上海的繁荣和浦东的开放,对发展长江三角洲、沿海的经济,对开发和发展崇明、长兴、横沙三岛都具有重要意义。

越江工程是跨世纪的宏大工程,投资大、技术复杂、涉及面广,前期准备时间长,因此对关键问题,如对规划三个越江通道位置的比较选释;河道变迁、工程地质、水文条件、江底地貌等勘测和调查;通航净空的专项论证;大跨度桥跨及基础结构、大直径隧道结构和施工机械、人工岛的技术可行性及其对河床的影响等都需作超前研究和论证,为越江工程位置的选择、越江方式的比较提供全面、可信的依据。

可以相信,在未来的若干年以后,长江口越江通道必将建成,它将是上海至苏北主要交通干道,它将为崇明、横沙、长兴三岛的开发开放提供重要基础条件。