Fig. 46 Runyang Yangtze River Bridge

The Yellow River is the second largest river in China. It originates also from the Tibetan Plateau in north of Yangtze River, with a total length of 5,464km, basin area795,000km2 and, finally empties itself into the Bohai sea. It is well known as sediment-laden river and the river channel of downstream is 4-7 meters higher than the ground outside the river on average, the maximum is up to 13 meters higher. There are about 90 bridges over this river now. Because the Yellow river is a vagrant river, in order to ensure safety long road bank is not admitted to be used when a road crosses it, such results many bridges over the Yellow River with a great length, especially in the down stream.

Zhengzhou Second Yellow River Highway Bridge completed in 2004 is a bridge with a total length of about 10km. It is divided into an 800 m-long main bridge and a 9035 m-long foreshore bridge as well as two abutments. The foreshore bridge is composed of 127 and 81 spans of PC simple beam bridges with a span of 35 m and 50m PC girders, respectively as well as 27 spans of PC slab bridges with a span of 20m. It is a key engineering project in the national highway trunk (express way) linking the north to the south from Beijing to Zhuhai in Guangdong Province. There are two separate bridges in the road section; each bridge carries 4 lanes in a direction and has a net width of 19.484 m. The main bridge is composed by 8 span of CFST tied arch bridges with a span of 100m as shown in Fig. 47.

Fig. 47 Zhengzhou Second Yellow River Highway Bridge

As we known, the coast area in China is the most developed area and is still developing in the fastest speed these days. Some large scale bridges for port and for road are constructed or under construction in this area in the last ten years, such as the connection road engineering project of the Zhoushan Island to the mainland in Zhejian Provice with a total length of 48km, including 23.745km of several bridges; the Hong Kong-Shenzhen Western Corridor and Deep Bay Link project with length of 3.2km and 5.4km respectively; Hangzhou Bay Bridge with a total length of 36km; the Donghai Bridge in Shanghai with a length of 31km.

Donghai Bridge (Fig. 48) is a collaboration work for Yanshan Deep Water Port, linking Shanghai with outlying Yangshan Island. The bridge carries six lanes of traffic, supported by

two separated superstructures, each one for three lanes with a clear deck width of 15.25m.

The Donghai Bridge with a total length approximately 31km consists of three parts of 2,264m long on the land from new bank to old bank of Luchao Harbor. The second part is a 25,322m-long bridge over the sea from new bank of Luchao Harbor to Tortoise Island. All of the four navigational spans of the Donghai Bridge are in this part. A cable-stayed bridge with double pylons, single plane and composite girders provides the main navigation span for 5,000DWT ships by its 420m main span. Three prestressed concrete continuous-beam bridges with main spans of 120m, 140m and 160m respectively, were designed as the three auxiliary navigational spans for 1,000DWT and 500DWT ships. Bored piles are used for these navigation bridges. The third part is a 3,160m long bridge from Tortoise Island to Yangshan Island. Construction of Donghai Bridge started at June, 2002 and was completed on at May, 2005.

(a) Bridge view (b) Construction site

Fig. 48 Donghai Bridge

The Hangzhou Bay Bridge (Fig. 49) located in the Yangtze River delta area, links the north and south shores of the Hangzhou Bay in the south of Shanghai. With a total length of 36km over the see bay, the bridge will cut the travel from Shanghai to Ningbo, Zhejiang Province, from 399km to 179km, resulting a 120km short journey. When completed, the bridge will be the longest "ocean-crossing bridge" in the World.

The bridge carries six lanes of traffic, supported by two separated superstructures, each one for three lanes with a clear deck width of 15.50m. It can be divided into five parts, two navigation bridges and three approach bridges. The north navigation bridge is a double-pylon steel-box-girder cable-stayed bridge with a span arrangement of 70m+160m+448m+160m+70m. The south navigation bridge is a single-pylon steel-box-girder cable-stayed bridge, whose arrangement of span is 100m+160m+318m.

As Donghai Bridge, the three approach bridges in Hangzhou Bay Bridge are also PC continuous girder. The approach bridge over sea to connect the two navigation bridges has a total length of 11060m long and 158m with standard span of 70m. The south and north approach bridge over deep water and sallow water has total length of 6720m and 490m respectively with also standard span of 70m. The south and north side onshore bridge has total length of 3250m and 2560m respectively with a various spans of 30m, 50m, 60 and 80m. The bridge in the south beach is 10100m long, consists of 202 spans with a standard span of 50m. For these bridges onshore as well as on north beach, PC girders cast in situ with spans of 30m to 80m are adopted.

Hangzhou Bay Bridge located in a very complicated sea environment. Qiantang tides in this place is one of the three biggest tides on the world, which can create huge, deafening waves, reaching as high as 7.5 m and moving at speeds of 24 to 29 km an hour. Moreover, serious effect of typhoons and the difficult content of the sea soil also make the construction

difficulty. The approach continues girders with standard span of 70m or 50m are erected by the simply supported-to-continuous beam method. There are 540 and 404 pieces of PC girder with a standard span of 70m and 50m, respectively. These great deal girders are fabricated in the factory, moved to the site by floating crane and erected.

A piece of PC girder with a length of 70m has a weight of about 2,200t. Special cranes of a capacity to hoist it to a height of 52m are designed and used in this bridge as shown in Fig. 25. In order to speed up the construction and guarantee the quality, many research works have been carried out, such as prefabrication equipments, steel formwork and steel skeleton for box-girder segment, proportional ratio for marine durable concrete, casting technique, transportation of heavy box-girder, precisely position adjusting of box-girder on the pier and so on. Construction of the super large scale bridge was started in 2004 and was completed in 2008.

(a) Image view

(b) Erection of girder

(c) Piers

(d) Construction site

(e) Bridge view

Fig. 49 Hangzhou Bay Bridge

At present, there are still some large scale bridge projects under construction in China, such as the Qingdao Bay Bridge, Shanghai Yangtze River Bridge. Qingdao Bay Bridge (Fig. 50) has a total length of about 35.4 km, of which the length of 26.75 km above the sea, bridge in land on the Qingdao's side of 5.85 km and the other side of Hongsiya of 0.9 km and a link Hongsiya to the island of 1.9 km. Three navigation bridges are cable-stayed steel box bridge with two tower and a main span of 260m, cable-stayed steel box with one tower and a

main span of 120m and a self-anchored suspension bridge with a single pylon and main span of 260m. The non-navigation spans over the sea are 60m span continue PC girders and the spans in the shore are 50m span continue PC girders. All of the foundations are drill cast-in-situ piles.

Fig. 50 Plan arrangement of Qingdao Bay Bridge

Shanghai Yangtze River Bridge project has a total length of 16.55 km, in which about 10 km over the sea as shown in Fig. 51. It is one part of the linking project with a 6 lanes in two ways from Shanghai to Chongming Island in the see outfall of Yangtze River. Between the island and the mainland, there is a small island named Changxing Island. In the south waterway, it is a tunnel project (total length of 8.95 km) and in the north waterway it is the Shanghai Yangtze River Bridge.

The estuary flow conditions in the bridge site are very complicated. The main navigation bridge is a cable-stayed bridge with a main span arrangement of 107+243+730+243+107m. The towers of the bridges are single plane, standing in the central line of the bridge. The bridge has been closed in June, 2008 and will be completed in 2010 by schedule.

Fig. 51 Image view of Shanghai Yangtze River Bridge

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Many information and data of this paper are obtained form the websites and other journals as listed in the appendixes.

Appendix A Some Websites on Bridge Engineering in China

Appendix B Correspondences of Some Associations for Bridge Engineering in China

Appendix C Some Books on Bridge Engineering in China

Appendix D Some Journals on Bridge Engineering In China