

虎門大橋

Humen Bridge

——现代桥梁新技术

—New Engineering Techniques of a Modern Bridge

广东省交通厅 主编

Edited by Communications Department
of Guangdong Province



广东科技出版社

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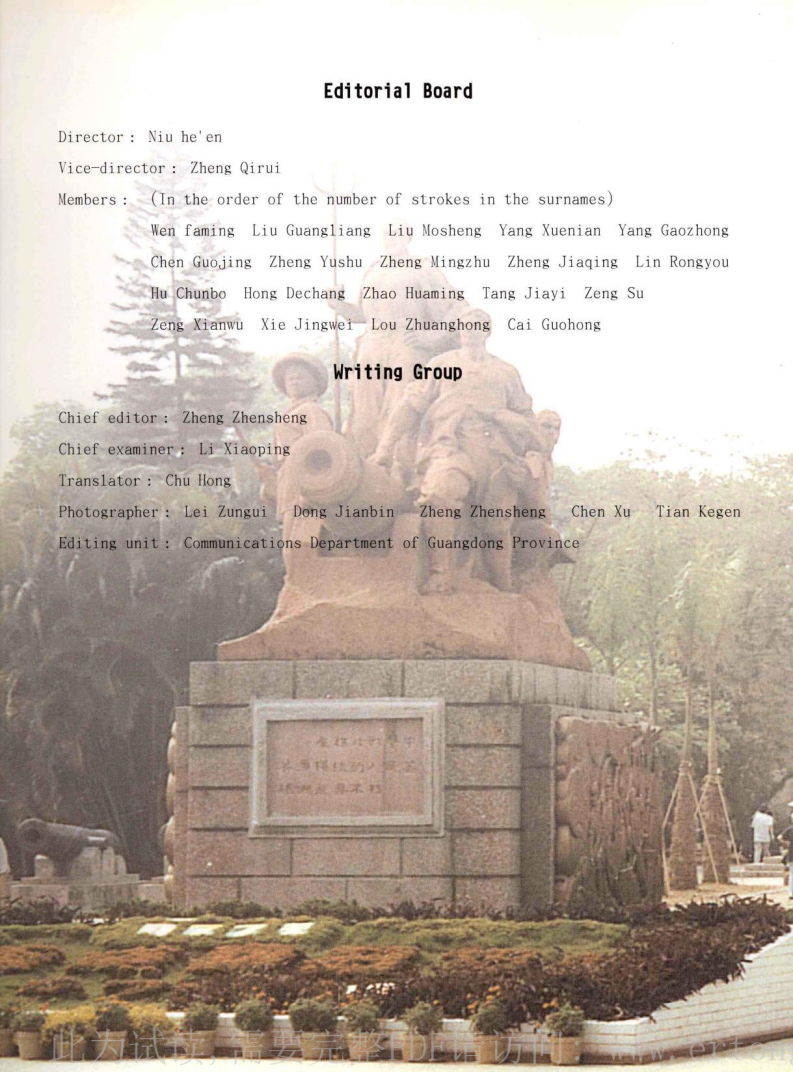
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序

举世瞩目的虎门大桥，于1997年5月胜利建成通车，它是一座跨世纪的特大型具有世界先进水平的现代桥梁。

虎门大桥工程全长15.76km，主桥全长4606m，其中主航道为悬索桥，跨径888m，是由中国人自行设计，率先施工，当时规模最大的高速公路现代悬索桥。辅航道为主跨跨径270m的预应力混凝土连续刚构桥，居世界同类型桥梁之首。

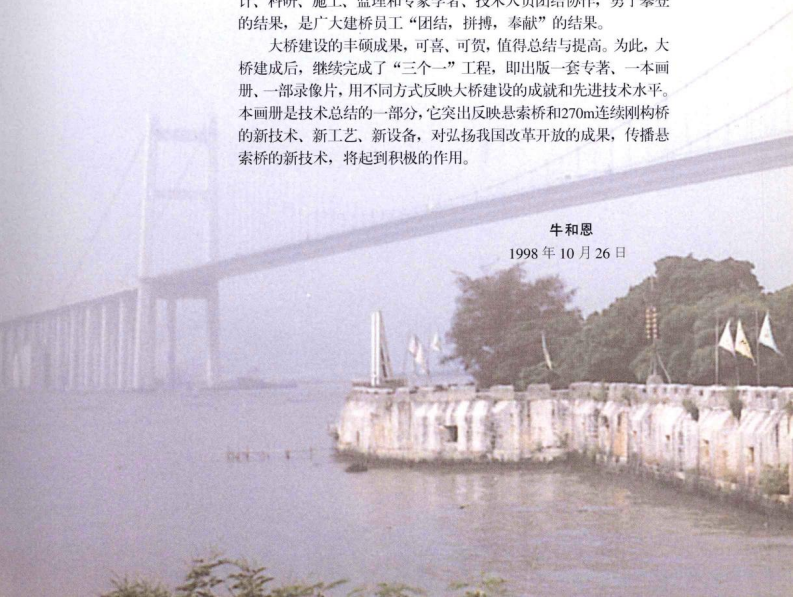
大桥工程规模浩大，技术先进，任务艰巨。桥梁和隧道总长10.48km，占全长66.5%。工期仅用4年6个月，创造了“优质，快速，高效”的好成果。这是集体力量与智慧的结晶，是先进技术水平的体现，是依靠科技、严格管理、精心设计、精心施工的结果。

在工程建设过程中，建设者们克服重重困难，攻破种种技术难关，锻炼培养了一大批技术人才，取得了丰硕的科技成果。如现场短线预制索股；加劲钢箱梁全焊接技术；液压提升跨缆吊机和卷扬机式提升跨缆吊机的研制成功，架设大吨位加劲钢箱梁；轻型鹰式挂篮在竖曲线和平曲线上大跨径270m连续刚构长悬臂施工，合龙时竖向相对高差仅3.3mm，创造了世界先进的新记录。大桥建设取得丰硕成果，是中央、省、市各级领导高度重视，关心的结果，是设计、科研、施工、监理和专家学者、技术人员团结协作，勇于攀登的结果，是广大建桥员工“团结，拼搏，奉献”的结果。

大桥建设的丰硕成果，可喜、可贺，值得总结与提高。为此，大桥建成后，继续完成了“三个一”工程，即出版一套专著、一本画册、一部录像片，用不同方式反映大桥建设的成就和先进技术水平。本画册是技术总结的一部分，它突出反映悬索桥和270m连续刚构桥的新技术、新工艺、新设备，对弘扬我国改革开放的成果，传播悬索桥的新技术，将起到积极的作用。

牛和恩

1998年10月26日



Preface

Humen Bridge, which becomes the focus of world attraction, was completed and opened to traffic successfully in May, 1997. It is a modernized extraordinarily large bridge with world advanced level leaping over the century.

Humen Bridge is 15.76 km in total length and 4606 meters long for the main bridge. Among which, the 888m-span suspension bridge is used for the main channel. Being designed by Chinese, it was the first to be constructed and then the biggest modern suspension bridge in scale on expressway. Over the auxiliary channel is a prestressed concrete continuous rigid frame bridge occupying the first place in the world bridges of the same kind, of which the main span is 270 meters.

This works is huge in scale with arduous task and advanced techniques adopted. The bridge and tunnel are 10.48 km in length, 66.5% of the total length. The works was completed in a period of only four years and six months with good results of "high quality, high speed and high efficiency" achieved. All these are the crystallization of collective strength and wisdom; reflection of advanced technical level and results of strict management, elaborate design and meticulous construction basing on science and technology.

During construction, all sorts of difficulties have been surmounted and various key technical problems have been resolved by the constructors. Meanwhile, a number of qualified technical personnel have been trained, and great scientific and technological achievements like on-the-spot prefabricating cable strands with short wires, all-welded technology of stiffening steel box girders, successful researching and manufacturing of hydraulic lifting cable-spanning crane and winch type lifting cable-spanning crane, setting up stiffening steel box girders of big tonnage, 270m-span continuous rigid frame long cantilever construction of light eagle-shaped form traveler at the vertical and horizontal curves and a vertical relative altitude difference of only 3.3 mm at joint etc. have been achieved with a new world advanced record set. Great successes in the bridge construction Cannot be achieved without the special attention and concern from leaders at all levels of the City, the Province and the Government; without unity & co-operation of experts and technicians being bold in scaling the heights for designing, scientific research, construction and supervision; without the spirit of "unity, striving, contribution" of all the staff members.

The great successes achieved in the construction of the bridge are to be congratulated and worth summarizing and improving. Therefore, "Three Ones Project", namely coming out a monograph, a atlas and a video tape, has been continued to perform after completion of the bridge. This picture album, being as a part of technical summarization, lays stress on reflecting new technology, new techniques and new equipment adopted in the construction of the suspension bridge and 270m continuous rigid frame bridge. This will play a positive role in developing achievements of reform and opening-up in China and spreading new techniques of the suspension bridge.

前言

雄伟壮观的虎门大桥已胜利建成通车，巍然耸立在鸦片战争的虎门古战场。

大桥工程浩大，主航道悬索桥施工时在国内规模最大，辅航道桥主跨为270m连续刚构居世界同类桥型之首。它的建成，在我国桥梁工程史上谱写了又一光辉的篇章，标志着我国公路桥梁建设技术跨入世界先进行列。

大桥建成后，在上级领导的支持帮助下，继续完成“三个一”工程，即出版一套专著、一本画册、一部录像片。用不同的方式来反映大桥建设的成就和先进技术。

本画册以详尽的文字资料和精美的彩色照片及插图，向读者介绍大桥工程的设计、施工、科研方面的新技术、新工艺、新设备、新经验。画册共分四章，第一章概述，第二章勘察设计，第三章工程施工，第四章科技攻关。文字部分约有3万字，彩色照片及插图近300幅，图文并茂，内容丰富多彩，介绍了各项工程技术中的具体内容和参数，通过照片和插图展示设计、施工、科研等方面的智慧和成果。

本画册由郑振声高级工程师与雷尊贵助理工程师撰写，编排与整理，郑振声同志主笔。提供彩色照片和插图的有雷尊贵、董建彬、郑振声、姜学勇、陈许、田可耕、王树林、盛赛华、高征铨、刘陌生、武玉琴、李毅、张友光、叶录年、陈仕周、叶映天、袁光宇等同志。画册的编辑、审稿、出版等工作，得到各方的大力支持，谨此向为本画册付出辛勤劳动的同志，表示衷心感谢！

由于参加大桥建设的单位和部门较多，虽努力反映各家的成就，但因时间关系，难以全面。内容上有谬误之处，敬请读者指正。

虎门大桥技术总结编委会

1998年9月



Introduction

Having been completed and opened to traffic successfully, the grand and magnificent Humen Bridge is towering aloft on the ancient battleground of the Opium War.

In the bridge works, the suspension bridge was the first to be constructed in China and the 270m span continuous rigid frame of auxiliary channel bridge occupies first place in the world bridges of the same kind. The construction of the bridge composes another brilliant chapter in the history of Chinese Bridge Construction Engineering and indicates that Chinese road and bridge construction techniques have reached to the world advanced level.

After completion of the bridge, "Three Ones Project", namely coming out a monograph, a atlas and a video tape, has been continued upon attention from higher leaders so as to reflect the achievements accomplished and advanced techniques used in the bridge construction in different ways.

The atlas introduces, new techniques, new equipment and new experiences on the bridge works' design, construction and scientific research through detailed written data and exquisite color photos and illustrations. It is divided into four chapters, among which Chapter I deals with Survey of Works ; Chapter II Prospecting and Design ; Chapter III Construction of Works and Chapter IV Scientific and Technological Problems Tackling. More than thirty thousand words are used for the written part and more than 280 color photos and illustrations are adopted. The atlas is rich and varied in content and shows wisdom and strength of design, construction and scientific research, etc. through detailed contents and various parameter concerning various engineering technology, and photos and illustrations.

The atlas is written by senior engineer Zheng Zhensheng and assistant engineer Lei Zongui. The color photos and illustrations are provided by the following people: Lei Zongui, Dong Jianbin, Zheng Zhensheng, Jiang Xueyong, Chen Xu, Tian Kegeng, Wang Shulin, Sheng Saihua, Gao Zhengquan, Liu Mosheng, Wu Yuqin, Li Yi, Zhang Youguang, Chen Shizhou, Ye Yingtian, Yuan Guangyu etc. We hereby express our heartfelt gratitude to all people who have committed hard work to the atlas and all circles who have given energetic support to editing, and publishing of the atlas.

Achievements of all units and departments attending the bridge construction have been showed through our great effort, while it is hard to cover all owing to the time limit. Readers are kindly requested to oblige us with valuable comments on mistakes in contents if any.

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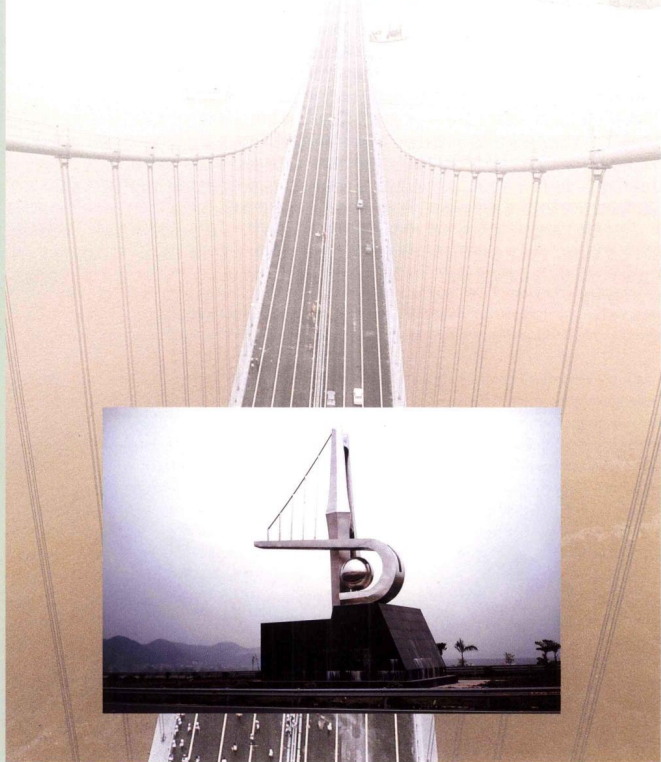
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第一章 概 述

Chapter I General Situation



虎门大桥工程位于广东省珠江三角洲的中部，坐落于鸦片战争的虎门古战场。是广州—深圳—珠海高速公路跨越珠江的一座特大型公路桥梁，东起东莞市虎门镇，与广州—深圳高速公路相接；西至番禺市的南沙开发区，与广州—珠海高速公路相连。是珠江三角洲高速公路网的重要组成部分，是广东沿海的重要公路交通枢纽，对沟通香港、澳门与广东沿海交通，促进国民经济的发展具有重大意义。

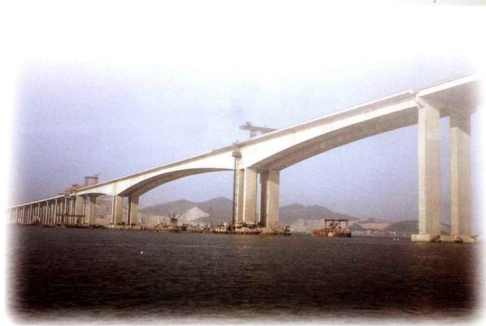
大桥工程包括主桥工程和两岸引道工程，全长 15.76km，其中桥梁、隧道工程长 10.48km，为工程全长的 66.5%。主桥工程中的主航道悬索桥，跨径 888m，为我国率先施工，当时规模最大的现代悬索桥；辅航道桥为主跨 270m 的预应力混凝土连续刚构桥，居世界同类桥梁之首。

主桥工程由交通部公路规划设计院设计，东、西引道工程由交通部第二公路勘察设计院设计。

大桥工程业主单位为广深珠高速公路虎门大桥有限公司，总投资为 29.4 亿元，由八家公司联合组成董事会进行投资。其具体的股东单位和投资份额如下：①广东省公路建设公司占 29%；②香港合和虎门发展有限公司占 10%；③国家开发投资公司占 10%；④东莞市路桥开发建设有限公司占 10%；⑤番禺市桥梁管理所占 10%；⑥香港先锋有限公司占 20%；⑦广东省路桥发展公司占 6%；⑧广州市公路开发公司占 5%。

大桥工程由公路一级施工企业——广东省长大公路工程有限公司(原称广东省公路工程总公司)总承包施工，广东虎门技术咨询公司负责施工监理，广东省交通厅工程质量监督站负责工程质量监督。实行政府监督，业主监理，施工自检三级质量管理。大桥工程于 1992 年 10 月 28 日动工兴建，1997 年 4 月 28 日竣工，历时 4 年 6 个月。大桥建成后，经过重载满荷的静、动载试验和自然气候的考验，工程质量满足设计和质量评定标准的要求。工程合格率达 100%，优良率达 85.7%。

虎门大桥工程建设，在中央、省、市各级领导重视和关心下，在地方政府、沿线群众、驻地子弟兵的大力支持下，经过各参建单位的共同努力和广大建桥员工四年多的日夜奋战，于 1997 年 6 月 9 日正式通车。江泽民总书记亲笔为虎门大桥题写了桥名。虎门大桥的建成通车为 1997 年香港回归祖国献上了一份厚礼。



Humen Bridge lies in the middle of Pearl River Delta of Guangdong Province and is situated on the ancient battleground of the Opium War. It is an extraordinarily large highway bridge striding over the Pearl River by Guang zhou-Shen zhen-Zhu hui Expressway. It starts from Humen town, Dongguan city connecting with Guang zhou-Shen zhen Expressway in the east and reaches to Nansha Development Zone in Panyu city connecting with Guang zhou-Zhu hai Expressway in the west. Being an important part of expressway network of Pearl River Delta, it is a key hub of highway communications in the coastal region of Guangdong and is of momentous significance in connecting communications among Hong Kong, Macao and coastal regions of Guangdong and promoting development of national economy.

The bridge work includes main bridge works and approach road works on both coasts with a total length of 15.76 km and tunnel works of 10.48 km in length occupying 66.5% of total length of the bridge work. Main channel bridge of the main bridge works is 888m-span suspension bridge which was the first to be constructed in China and the biggest modern one in scale on Expressway in China at that time; 270m-span prestressed concrete continuous rigid frame bridge is used for auxiliary channel bridge occupying first place in the world bridges of the same kind.

Main bridge works was designed by Highway Planning & Designing Institute of the Ministry of Communications; East and west approach road works were designed by the Second Highway Prospecting & Designing Institute of the Ministry of Communications.

With Guang zhou-Shen zhen-Zhu hai Expressway Humen Bridge Co., Ltd. as the owner of the bridge work, the total investment is RMB 2.94 billion Yuan invested by the Board of Directors organized jointly by eight companies of which the shareholder units with their invested share are detailed as follows: (1) Guangdong Provincial Highway Construction Co., 29%; (2) Hongkong Hopewell Humen Development Co., Ltd., 10%; (3) State Investment & Development Co., 10%; (4) Dongguan Municipal Road and Bridge Development & Construction Co., 10%; (5) Panyu Municipal Bridge Administration, 10%; (6) Hongkong Pioneer Co., Ltd. 10%; (7) Guangdong Provincial Road and Bridge Development Co., 6%; (8) Guangzhou Municipal Highway Development Co., 5%.

The bridge work was contracted by Guangdong Provincial Changda Highway Engineering Co., Ltd. (former Guangdong Provincial Highway Engineering General Co.), the first grade highway construction enterprise. Guangdong Humen Technological Consulting Co. was responsible for construction supervision and management. Engineering Quality supervision Station of Communications Department of Guangdong Province was in charge of Engineering supervision. Three-grade quality management of Government supervision, Owner supervision and management, construction self-testing is implemented in the construction. The bridge work started to be constructed on October 28th 1992 and was completed on April 28th 1997 with a period of four years and six months. After completion, works quality has been proved to meet the requirements of design and quality appraisal standard through dead and movable load testing of heavy and full load and natural weather testing with qualified rate of 100% and fine quality rate of 85.7%.

With attention and concern from leaders at all levels of the Government, the Province and the City; with energetic support from local government, the masses and garrison; with joint effort made by every units having participated in the construction and four years hard work day and night by all staff for construction of the bridge, the Humen Bridge works was completed and opened to traffic formally on June 9, 1997. General secretary Jiang Zemin inscribed bridge name for Humen Bridge in his own handwriting. The completion and opening to traffic of Humen Bridge was a generous gift presented to 1997 Hong Kong Returning to China.



图1-1 虎门大桥主桥工程全景

Fig.1-1 The full view of the main bridge works of Humen Bridge.





图 1-2 主航道悬索桥俯视

Fig.1-2 Overlooking the suspension bridge above the main channel.

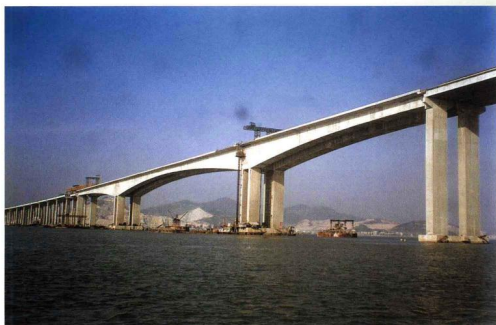


图 1-3 辅航道跨径 270m 连续刚构桥全景

Fig.1-3 The full view of 270-m span continuous rigid frame bridge over the auxiliary channel.