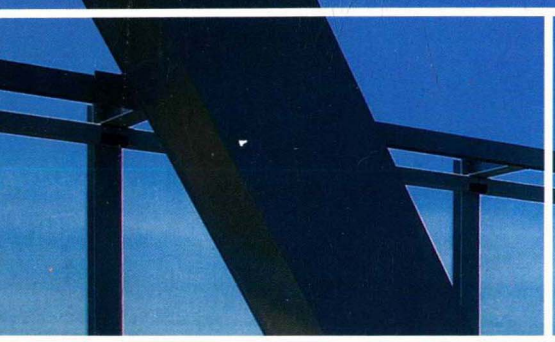
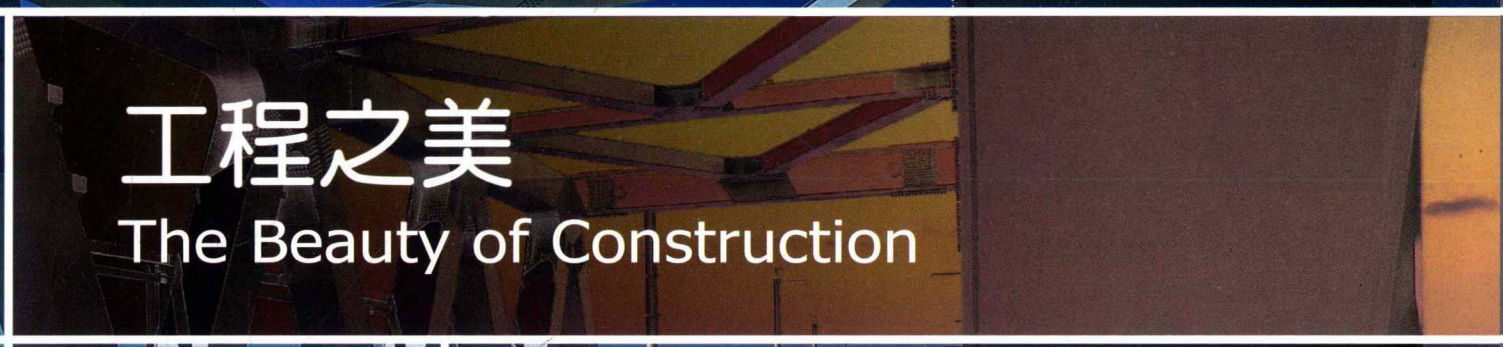
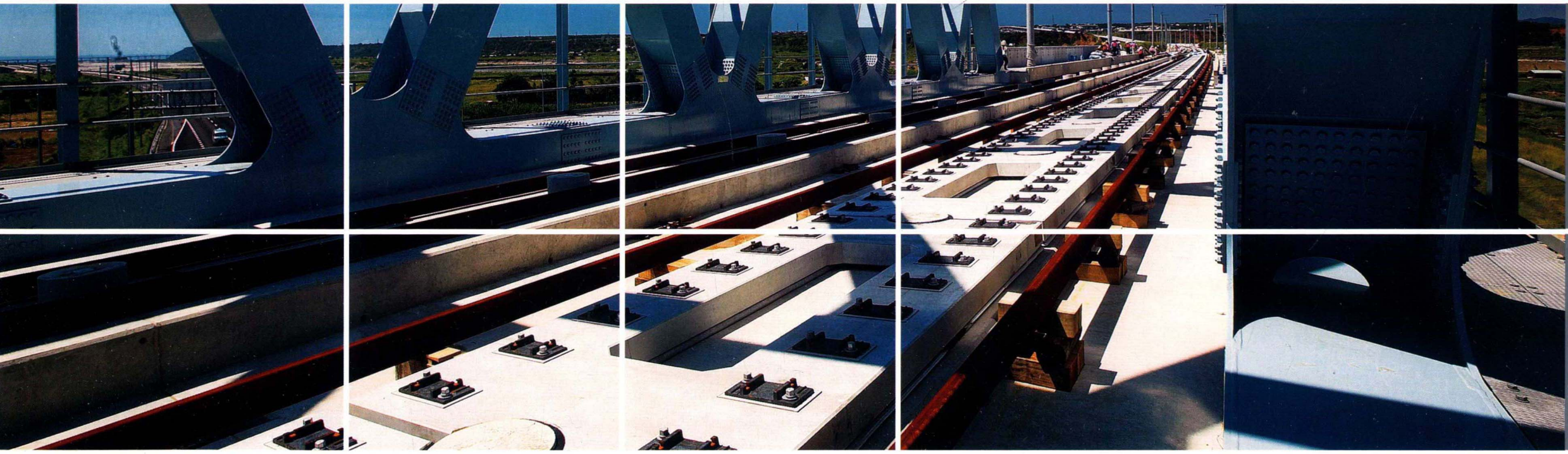
高速鐵路

The Beauty of Construction

工程之美







交通部高速鐵路工程局編著

高速鐵路建設成果系列畫冊2

工程之美

HSR Project Results Pictorial Volume 2

The Beauty of Construction

發 行 人 ： 龐家驊
發 行 所 ： 交通部高速鐵路工程局
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電 話 ： (+886-2)80723333 轉8261
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總 編 輯 ： 黃孝思
文字編輯 ： 李宏仁 詹子瑩 鄭雯文 范姜燮
美術設計 ： 賴小萍
美工題字 ： 廖銘星
攝 影 ： 黃孝思
衛星版權 ： 國立中央大學太空及遙測研究中心
翻 譯 ： 國際翻譯社

編輯製作 ： 台灣世曦工程顧問股份有限公司
電 話 ： (+886-2)27363567
執行編輯 ： 賴小萍
製版印刷 ： 磐古印刷科技股份有限公司
版（刷）次 ： 初版一刷

出版年月 ： 中華民國97年08月
定 價 ： 新台幣1,200元
ISBN ： 978-986-01-5061-2
GPN ： 1009702071
展售處 ： 國家書店松江門市
地址：10485台北市松江路209號1樓
電話：(+886-2)25180207
網址：http://www.govbooks.com.tw

五南文店化廣場
地址：40042台中市中山路6號
電話：(+886-4)22260330
網址：http://www.wunanbooks.com.tw

國家圖書館出版品預行編目資料

工程之美 = The Beauty of Construction /
[交通部高速鐵路工程局編著]. -- 初版.--
臺北縣板橋市 ： 交通部高鐵局, 民 97.08
136 面; 34X31 公分. --(高速鐵路建設成果系列畫冊 ; 2)中英對照
ISBN 978-986-01-5061-2(精裝)
1.鐵路工程 2.高速鐵路 3.攝影集 4.臺灣
442.83025 97015240

Publisher : Jar-Hua Pang
Published by : Bureau of High Speed Rail, MOTC
Address : 9F, No. 7, Sec. 2,Sianmin Blvd., Banciao City, Taipei County, 22041, Taiwan (R.O.C.)
Telephone : (+886-2)80723333 ext 8261
Web Site : http://www.hsr.gov.tw

Guiding Member : Hsiang-Ling Hu, Fung-Yuan Gou, Chia-Ling Cheng, Hsiang-Hwa Lu

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Managing Editor : Hsiao-Shih Huang
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Art Designer : Hsiao-Ping Lai
Art Inscription : Ming-Hsing Liao
Photographer : Hsiao-Shih Huang
Satellite Photo Copy : Center for Space and Remote Sensing Research National Central University
Translation : International Translation Service (ITS)

Editing Production : CECI Engineering Consultants, Inc., Taiwan
Telephone : (+886-2)27363567
Executive Editor : Hsiao-Ping Lai
Printing : Parnku Print Technology Co., Ltd.
Release : First Printing

Publishing Date : August 2008
Price : NT$1,200
ISBN : 978-986-01-5061-2
GPN : 1009702071
Exhibition/Selling : Songjiang Store of National Books Company
ADDRESS:1F., No.209, Songjiang Rd., Jhongshan District, Taipei City 10485, Taiwan (R.O.C.)
TEL:(+886-2)25180207
HTTP://www.govbooks.com.tw

Wunan Culture Square
ADDRESS:No.6, Jhongshan Rd., Central District, Taichung City 40042, Taiwan (R.O.C.)
TEL:(+886-4)22260330
HTTP://www.wunanbooks.com.tw

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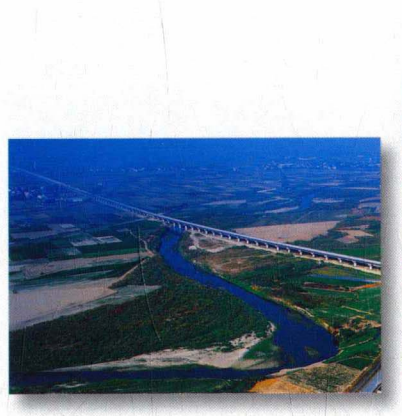

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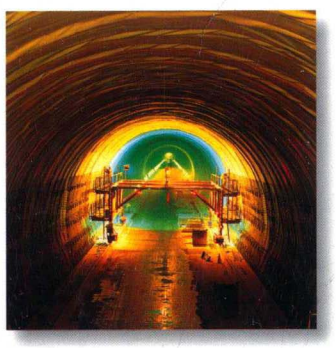

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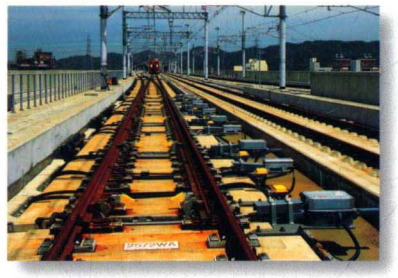

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高速鐵路

工程之美
The Beauty of Construction

交通部高速鐵路工程局編著

序・PREFACE

部長序

交通部本著以人本為立場、民意為依歸，持續推動以「綠色運輸」為導向的交通運輸系統。在全球油價及原物料飛漲的年代，強化交通運輸能量與效率的台灣高速鐵路，正是運輸服務新世代來臨的一個表徵。第12屆總統、副總統就職典禮特別史無前例帶領各國重要外賓搭乘高鐵，經由實際的體驗，感受台灣高鐵之快速、舒適，並藉此彰顯政府落實節能減碳政策的決心。

高速鐵路建設計畫係依照立法院的決議，根據「獎勵民間參與交通建設條例」，採由民間投資興建營運後移轉政府(Build-Operate-Transfer, BOT)之方式辦理。交通部於1998年7月23日與台灣高鐵公司簽訂高鐵「興建營運合約」(特許期35年)及「站區開發合約」(特許期50年)，是目前世界上採BOT方式推動、規模最大的交通建設。本計畫包含土建工程、車站工程、基地工程、軌道工程及核心機電系統工程，皆採國際通行之統包合理標方式辦理公開招標，並引進嚴格之品保制度與施工管理方式，透過國際工程團隊與本國營造業之分工與合作，快速的完成各項工程。施工中使用許多由國外引進之工程技術，為了能將新技術之經驗根留台灣，高速鐵路工程局用心詳實記錄施工的點點滴滴，編撰成冊，為下一代留下許多軌道工程的寶貴文化及歷史資源。

本畫冊將高鐵興建過程重要影像記錄下來，期使台灣高速鐵路工程之興建過程，能留下完整記錄與歷史見證；也期盼藉此書能將難得的經驗與大家分享，有助於提昇國人對高鐵建設的了解，進而增進國內公共工程之品質及營建自動化之推動，共同體驗高鐵舒適便捷的旅運服務，讓更多人共享台灣高鐵興建完工及營運成功的喜悅。

交通部 部長

毛治國 謹識

Preface by Minister

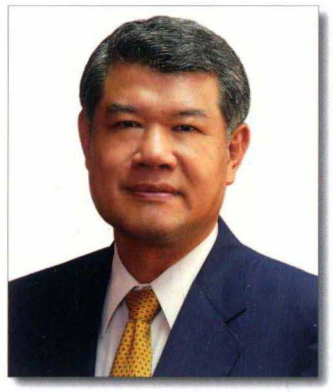
The MOTC is continuing to promote "green transportation" systems in line with its policy of attention to the wishes of the people with a humanistic approach. At this time of high petroleum and raw material prices, the HSR signals the coming of a new era of high-capacity and high-efficiency transportation services, as well as the Government's commitment to achieving the goals of energy conservation and the reduction of carbon emissions.

The HSR project was approved by the Legislative Yuan in accordance with the Statute for Encouragement of Private Participation in Transportation Infrastructure Projects, and has been implemented as a build-operate-transfer (BOT) project. The MOTC signed a BOT contract (incorporating a concession period of 35 years) and a station area development contract (incorporating a concession period of 50 years) with THSRC on July 23, 1998. At the time of construction the HSR system was the world's largest transportation project being implemented via a BOT procedure. The project included the civil construction, stations, depots, track project, and the installation of core E&M system contracts, all of which were awarded to the most successful of the contract bidders in an open international tendering process. Strict QA and construction management systems were adopted, and multinational engineering teams cooperated with partners in the domestic construction industry, to complete the project with the utmost speed.

This book contains many important images of the HSR construction process, which we hope will provide a complete record of the construction of the HSR project and form a historical record of value. We also hope that this book will demonstrate the project's hard-won experience, increase citizens' understanding of how the HSR was built, and thereby extend their knowledge of domestic public-works construction and promote the use of automation in modern construction. Perhaps more of the citizens experiencing the speed and comfort of HSR trains will appreciate the tremendous achievement and share in the success of the HSR project.

Minister

Ministry of Transportation and Communications



次長序

台灣高速鐵路於2007年1月5日通車後，成為台灣西部重要的長途交通動脈之一，亦為臺灣交通工業指標。通車至今短短的一年多的時間累積載客量已突破3,000萬人次，這段時間我國交通運輸系統在「質」與「量」的方面也已悄悄的產生變化，高鐵結合鐵路、公路及都會區捷運系統，形成高效率之大眾運輸路網，提供便捷的交通服務，在油價高漲的時代，搭乘高鐵能有效的使用及節約能源、減少轎車的使用，除能達到節能減碳外，並可解決以往國道壅塞及都會區的停車問題，使南北通車時間倍速縮短、區域城鄉距離快速拉近，高鐵的營運正在引領國人邁向優質新生活。

本人在高速鐵路工程局任內開啟了高鐵技術叢書的出版工作，有感於高速鐵路工程局除了負有全力的監督台灣高鐵的施工品質與效率外，對於工程新技術的記錄與傳承，也是一個不可推卸的重責大任；去年『高速鐵路建設成果系列畫冊1 台灣高速鐵路啟航新紀元』一書發行後獲得各界廣大熱烈的迴響，本人感到相當欣慰，這一系列叢書的發行，不僅是一個歷史見證的紀錄，更是一般台灣人民了解高鐵建設良好的溝通管道。

最後值得一提的是，這本畫冊內每一禎照片所呈現的影像，其實都是許多無名英雄在背後默默的努力與無盡的付出所得到的豐收果實。圖片詳實記錄工程的浩大與艱辛及參與施工人員們的辛勞，一步一腳印踩出高鐵的成就之路，所有曾經參與高鐵建設設計、興建及營運的人，都是我們心目中所崇敬，我們期許未來高鐵建設能引領全國人民前進希望、快樂的新優質生活國度。

交通部 常務次長

何煖軒 謹識

Preface by Vice Minister

The High Speed Rail System became one of most important long-distance transportation arteries in western Taiwan soon after it began operating on January 5, 2007, and is now a clear indicator of the state of Taiwan's transportation industry. Although it has only been little more than a year since the system opened, the HSR has already carried 30 million passengers. The quality and capacity of Taiwan's transportation systems have been gradually improving during recent times , and the HSR has functioned in tandem with the railways, highways, and urban metro systems to create a convenient, high-efficiency land-based transportation network for the public. During this time of soaring oil prices, taking the HSR can conserve energy, reduce car use, lessen carbon emissions, and ease freeway traffic congestion and urban parking problems. The HSR halves the time that is needed to travel between northern and southern Taiwan, eases the journeys between urban and rural areas, and gives our citizens a better quality of life.

I initiated the HSR Technical Monographs series while at BOHSR, and I feel that BOHSR, apart from its responsibility for supervising the quality and efficiency of the HSR construction project, is also obligated to record and transmit the project's new technologies. Last year's "HSR Project Results Pictorial Volume 1: Taiwan HSR Launches a New Era" received an enthusiastic welcome from the public. Besides being merely a historical record, this book also serves as an effective communication channel helping the people of Taiwan to understand the HSR system and services.

Finally, it must be mentioned that every photographic image in this book is the result of the hard work and endless commitment of countless contributors. As well as the vast scale and difficulty of the project, the photographs that have been included also record the great dedication of everyone who participated in its construction and ensured it's success. We hold those individuals who have taken part in the design, construction, and operation of the HSR project in the highest respect. We sincerely hope that the HSR will lead citizens to a brighter future and a better quality of life.

Wan-Hsuan Ho

Vice Minister

Ministry of Transportation and Communications

序・PREFACE

局長序

高速鐵路的通車營運無疑是台灣公共工程建設的一件大事，全國人民一起見證了高鐵這項浩大工程的誕生。這是台灣軌道發展史上的一個重要的里程碑，多少人經過血汗交織的努力，也是政府與民間的一次美妙的合作，將台灣交通運輸順利的推向國際的舞台發光發熱。

台灣南北高速鐵路計畫為我國政府首度推動採取民間投資參與的重大國家基礎建設，本計畫包含土建工程、車站工程、基地工程、軌道工程及核心機電系統工程。整個計畫一次全面動工，以期能儘快達成投資效益的回收，為本工程的特色，故其工程面臨著規模及時程上嚴峻的挑戰和考驗，施工過程使用的機具、發進基地隨著工程完工後已經消失，整個工程經過施工破壞地貌到完工地恢復原狀，高鐵建設過程如何降低對大自然的傷害與大自然共生，這些都是一般國民在體驗高鐵的快速、便利、安全時難以體會了解的一面。有感於此，交通部高速鐵路工程局除已出版「高速鐵路建設成果畫冊1 台灣高速鐵路啟航新紀元」一書，專輯報導高鐵營運與通車歷史紀錄外，更彙整高鐵工程興建期年間百幅施工全紀錄，本「工程之美」畫冊以雄偉的觀點、美感的角度切入，精選土建、軌道及核心機電工程方面圖片及資料，期盼本書的出版能拉近國人與高速鐵路工程間的距離，除對高速鐵路工程施工技術宣導外，並希望透過美麗的施工圖片讓人感受工程施工的另一個風貌。

本人特別藉由這本畫冊的出版，感謝在工作崗位上默默付出的每一個人，全國人民才可以在這一刻享受高鐵帶來的便利、安全、高品質的運輸新體驗。其次，本書可以順利付梓，特別感謝在審查期間提供專業協助及指正的台灣高鐵公司委員們，及局內為此書不辭辛勞努力付出的同仁們。期盼本書的出版，可以引領一般國人體驗高鐵工程的浩大與艱辛，並感受工程技術以外的工程景觀美感之體驗。

交通部高速鐵路工程局 局長

謹識

Preface by Director General

The opening of the HSR is unquestionably a major event in Taiwan's public construction history, and citizens have witnessed the emergence of this landmark project. The HSR is undoubtedly a major milestone in the development of rail transportation in Taiwan, and its success comes as a result of the untold toil and effort on the part of countless individuals. The HSR is also the result of outstanding cooperation between the Government and private enterprise and it propels Taiwan's transportation system into the international limelight.

The Taiwan High Speed Rail Project is the first time that the Government of Taiwan has allowed private investors to participate in a major national infrastructure project. The project has included the civil construction, stations, depots, track project, and the installation of core E&M system contracts. All works commenced at the earliest possible times in an effort to recover financial investments as quickly as possible. As a result, the project faced immense challenges with it's enormous scale of operations and limited time schedules. The equipment and construction sites used for the project have now disappeared and the entire project is finally complete and in operational service. Passengers who take the HSR and enjoy its speed, convenience, and safety may find it hard to appreciate how the project was undertaken.

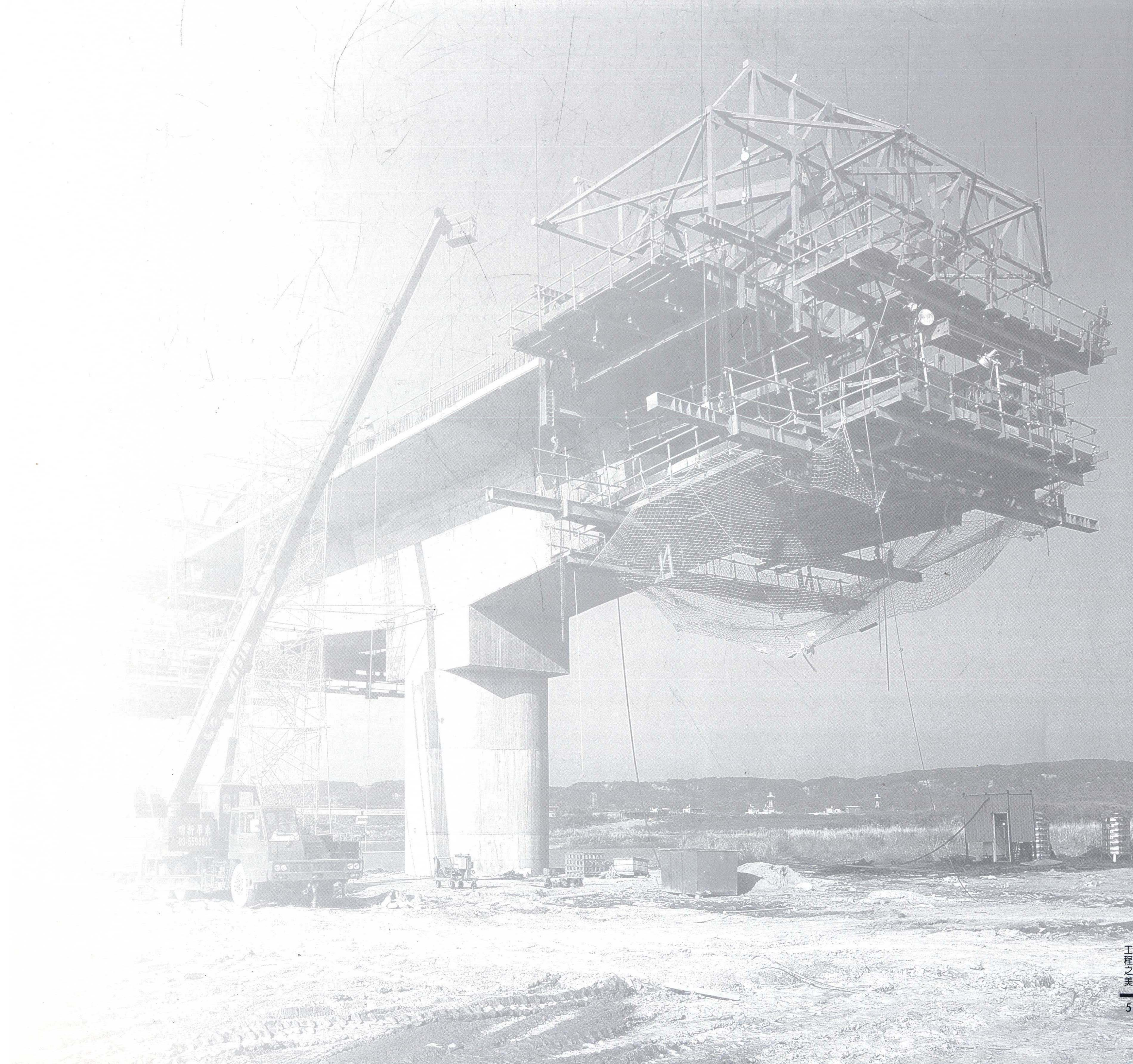
One item in particular was the landscaped areas of the construction work-sites that were initially disturbed but which were finally restored to their original state and condition upon completion of the railway works, with deliberate emphasis being placed on environmental issues throughout the process.

BOHSR's publication of the book "HSR Project Results Pictorial Volume 1: Taiwan HSR Launches a New Era" provided a historical record of the HSR's opening and operational services, and contained a complete photographic record of the construction period. This "Beauty of the Construction" pictorial volume illustrates the project in photographs that have been taken from the most ideal viewing angles and advantage-points, while it's contents include photographic material and supporting data which record the construction of the civil construction, track project, and the installation of the core E&M system contracts. Beyond familiarizing citizens with the HSR project and the techniques used in the construction, we hope that the excellent construction photographs that are contained in this book will make people aware of the splendor and appeal of the project.

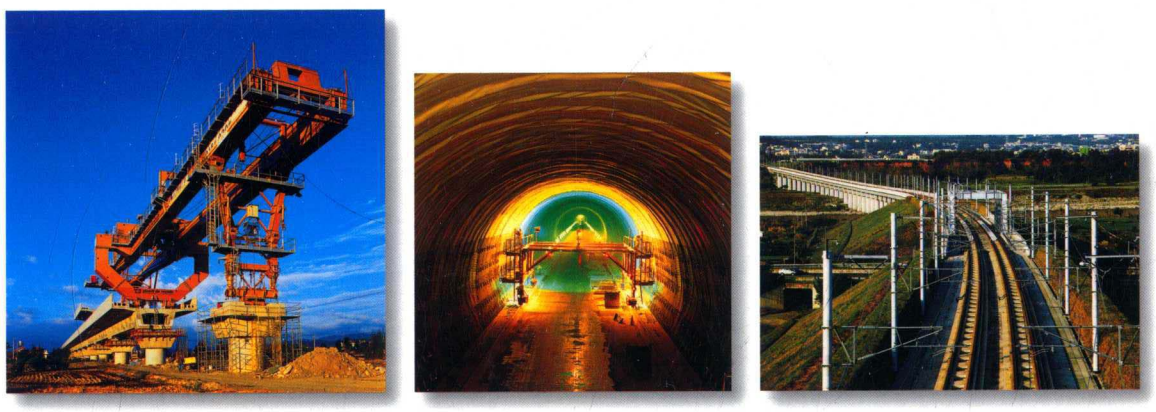
I would like to take this opportunity to thank all of those individuals who worked so diligently to enable the public to enjoy the convenience, safety, and unique transportation experience of the HSR. Furthermore, with the successful publication of this book, I am also expressing my gratitude to the members of THSRC who provided their professional assistance and comments during the review period, as well as to all of my colleagues at BOHSR who labored to make this project a success. I hope that this book will make ordinary citizens aware of both the splendour as well as the technical difficulties of developing the HSR project, and, apart from the engineering technology involved, let them appreciate the grandeur of the construction.

Director General

Bureau of High Speed Rail, MOTC



目錄・CONTENTS





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工程概述・Project Overview

台灣高速鐵路於96年3月2日全線通車，實現了台灣西部走廊一日生活圈的願景，帶動區域均衡發展，縮短城鄉差距，截至97年4月為止，累計實際載客已逾2,300萬人次。台灣高速鐵路工程主要包含土建工程、車站工程、基地工程、軌道工程及核心機電系統工程等項目。

土建工程全線長達345公里，其中台北縣樹林市至台北市南港區，長約16公里之地下隧道工程，由政府配合鐵路地下化工程負責興建。其餘台北縣樹林市至高雄市左營區，長約329公里之工程，則由特許公司-台灣高速鐵路公司負責，共分為12個標段，包含251公里高架橋段，47公里隧道段及31公里路工段。各項工程分別由國內外廠商聯合承攬興建，其中橋梁總長度約佔路線全長七成以上，尤以彰化八卦山以南路段均採高架橋設計，橋梁連續總長度約157公里，已締造台灣連續高架橋長度之新紀錄。隧道部份總長度約47公里（不含政府辦理之台北段地下隧道工程），含鑽掘隧道42座，明挖覆蓋隧道6座。其中有4座長隧道：龜山隧道（長6,482公尺）與八卦山隧道（長7,364公尺），為通過卵礫石層之隧道；迴龍隧道（長2,149公尺）與湖口隧道（長4,275公尺），為通過砂頁（泥）岩層之隧道。為避免因高速鐵路路線通過，造成路線兩側交通阻隔，路堤或路塹約僅佔路線全長一成，以減緩對自然環境之衝擊。

高速鐵路設台北、桃園、新竹、苗栗、台中、彰化、雲林、嘉義、台南、左營等10個站。除台北、板橋站由政府興建外，其餘8站由台灣高速鐵路公司興建。車站型式除台北、板橋站與台鐵共構興建、桃園車站(含行控中心)採地下型及左營車站採平面型設計外，其餘車站型式皆為平面高架型式。

軌道工程採設計與施工合一之發包方式辦理共分T200、T210、T220、T230及T240等5個標。全線345公里，除左營車站約3公里路段，採道碴軌道鋪設外，其餘均採用道版軌道鋪設。由國外營造廠商以聯合承攬方式辦理，於91年6月開工，並於94年6月完工。其中T240標之範圍涵蓋試車線路段，T200標為台北市區鐵路地下化隧道段（包括台北站及板橋站）。基地工程包括汐止、六家、烏日、太保及左營基地與燕巢總機廠等6座。除了燕巢總機廠主要負責車輛修理，其餘5座基地主要提供工務與電務維修服務以及車輛之調度。在營運初期，燕巢總機廠及六家、烏日、太保、左營4座基地先行配合運作；汐止基地則將配合實際使用之需求再行興建。

高速鐵路核心系統，分為設計製造及整合安裝測試2標。為確保台灣高鐵系統能在主要機電之各子系統間獲得平順及安全之整合性，特別採以統包方式，採用日本新幹線之技術，由單一核心機電系統承攬廠商來提供各項設備。核心機電系統共分為電力、號誌、通信、車輛及道旁機電等5項子系統。

工程概述・Project Overview

The start of revenue service along the full HSR line on March 2, 2007 realized the vision of making Taiwan's western corridor a one-day living zone, stimulated balanced regional development, and reduced the divide between urban and rural areas. The HSR had carried a cumulative total of 23,000,000 passengers by April, 2008.

The HSR project consists mainly of civil construction, stations, depots, track project, and installation of core E&M system contracts. The civil construction portion of the project encompassed the entire 345km HSR line. The 16km underground segment from Shulin in Taipei County to the Nangang District of Taipei was built by the Government in conjunction with other railway tunneling work. The remaining 329km section from Shulin in Taipei County to the Zuoying District of Kaohsiung was built by the concession-holder—Taiwan High Speed Rail Corporation (THSRC). This section of the works consisted of 12 construction contracts sections, and comprised 251km of elevated track, 47km of tunnels, and 31km of embankments and roadcuts. A number of domestic and foreign joint venture contractor tendered for the project. Bridges and viaducts account for 70% of the length of this section, and all track south of Baguashan in Changhua County is elevated on approximately 157km of continuous viaduct. This set a new record for the length of viaduct in Taiwan. The total length of tunnels in this section is approximately 47km (not including underground track in the Taipei area constructed by the government). There are 42 bored tunnels and 6 cut and cover tunnels. There are 4 long tunnels: The 6,482m Gueishan tunnel and the 7,364m Baguashan tunnel both pass through conglomerate layer; the 2,149m Hueilong tunnel and 4,275m Hukou tunnel pass through sandy shale and mudstone. In order to avoid disruption to transportation along and between the two sides of the HSR line and to minimize the impact on the environment, embankments and roadcuts account for only 10% of the HSR route.

The station buildings portion of the project consisted of the establishment of 10 stations at the locations of Taipei, Taoyuan, Hsinchu, Miaoli, Taichung, Changhua, Yunlin, Chiayi, Tainan, and Zuoying. With the exception of the Taipei and Banciao Station structures, which were formally built by the Government, the remaining 8 stations were built by THSRC. Apart from the Taipei and Banciao Stations, which

were originally constructed by the Taiwan Railway Administration (TRA), Taoyuan Station (including the Operation Control Center), which is underground, and Zuoying Station, which is a ground-level structure, the remaining stations are ground/elevated structures.

The track project consisted of the 5 contracts T200, T210, T220, T230, and T240, where the contractors were responsibility for both design and construction works. Track consists of both ballasted and non-ballasted sections. Except for approximately 3km of ballasted track at the Zuoying station, the entire 345km HSR system employs non-ballasted slab track. A number of foreign joint venture contractor tendered for the full extent of the track project. Work began on the track in June 2002, and was completed in June 2005. The scope of contract T240 included the test track section, and the scope of contract T200 included the underground section in the Taipei area (including Taipei and Banciao stations). The depot facilities portion of the project included the Yanchao Main Workshop and depots at Sijhih, Lioujia, Wurih, Taibao, and Zuoying. Apart from the Yanchao Main Workshop, which undertakes rolling stock repair, the other 5 depots primarily provide mechanical and electrical maintenance and rollingstock dispatching services. The Yanchao Main Workshop and depots at Lioujia, Wurih, Taibao, and Zuoying have been in operation since the HSR commenced operation; while the Sijhih depot will be built in the future; when required.

The HSR's core E&M system consisted of 2 separate contracts for the design & manufacture work and for the integration & installation works. A specific contracting approach was employed to ensure that the various E&M subsystems could be coordinated efficiently and fully integrated; with safety as a priority. Japan's Shinkansen technology was adopted and a single core E&M system contractor provided all the requisite equipment. The core E&M system consists of power, signals, communications, rolling stock, and wayside E&M subsystems.

土建工程 · Civil Construction

高速鐵路建設計畫之興建及營運，政府除辦理監督與管理外，尚包括南港板橋段路線土建工程之規劃、設計與施工(不含軌道、機電、營運設施及此段工程必要之修改)，以及本計畫用地取得等事項。其餘由台灣高速鐵路公司以BOT方式(Build-Operate-Transfer；即由民間投資興建及營運，於特許期間屆滿後，將資產移轉給政府方式)取得特許權，將高速鐵路土建工程分為C210、C215、C220、C230、C240、C250、C260、C270、C280、C291、C295及C296等12個標，各標工程長度最短3.062公里(C296標)，最長42.799公里(C270標)，並以設計與施工合一之方式(Design-Build)遴選國內外營造廠商以聯合承攬(JV, Joint Venture)之方式辦理。其路線結構包含橋梁251.3公里(76.2% ，主要採用全跨預鑄吊裝工法、支撐先進工法、就地支撐工法與場鑄懸臂工法等）隧道47.2公里(14.3% ，以新奧工法(NATM)設計及施工）路堤14.8公里(4.5%)以及路塹16.4公里(5%)。土建工程於89年3月開工，於93年11月全部完工。

In addition to supervising and managing the construction and operation of the HSR system, the government was directly involved in the planning, design, and civil construction of the Nangang-Banciao section (not including track, E&M, operating facilities, and engineering modifications), and also handled the task of the project's land acquisition. Other work was implemented by THSRC, who obtained a concession to build and operate the system via a BOT contract arrangement (Build-Operate-Transfer: the system is built and operated with private investment, and assets are transferred to the government after the end of the concession period). The HSR civil construction project comprises the 12 contracts C210, C215, C220, C230, C240, C250, C260, C270, C280, C291, C295, and C296. The length of the contract sections range from 3.062km (C296) to 42.799km (C270). Combinations of domestic and foreign joint ventures were selected as 'design-and-build' contractors. The track route includes 251.3km of viaducts (76.2%) constructed mainly using the full-span precast & launching, advancing shoring, ground shoring, and balanced cantilever methods. There are also 47.2km of tunnels (14.3%) constructed using the new austrian tunneling method (NATM), 14.8km of embankments (4.5%) and 16.4km of roadcuts/cuttings (5%). Work began in March 2000 and completed in November 2004.