Building Materials and Technology in Hong Kong

香港建築技術及應用

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HKU PRESS
香港大學出版社

Hong Kong University Press
The University of Hong Kong
Pokfulam Road
Hong Kong
www.hkupress.hku.hk

ISBN 978-988-8390-98-4 (*Hardback*)

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

10 9 8 7 6 5 4 3 2 1

Printed and bound by Hang Tai Printing Co. Ltd., Hong Kong, China

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Foreword

The mission of the Hong Kong Institute of Architects is to promote the general advance of architecture and to promote and facilitate the acquisition of the knowledge of the various arts and science connected therewith. The Institute also strives to raise the standard of architecture in Hong Kong and of professional architectural services offered by its members. I have found the purpose of this book aligned with the mission of the Institute.

As architects, we design building forms with respect to function, to fulfil the need of users, and to comply with the current building laws and codes. Further, it is essential for architects to be equipped with an understanding of building components and the knowledge of building materials and technology. It is often with this knowledge of how buildings are assembled that innovative ideas are materialized.

Construction technology is a subject undergoing continuous development, directly or indirectly influenced by technological advancement, people's aspiration for sustainability, changes in building laws and codes, and local market conditions. I am therefore pleased to note that this edition has been updated with case studies of recent local projects, such as CIC Zero Carbon Building and domain-redevelopment of Yau Tong Estate Phase 4.

I commend the lead author, Dr Wong Wah Sang, a renowned architect and educator, for his commitment, persistence, and unfailing efforts in sharing his valuable research with his co-authors in the profession. I am pleased to recommend this book as a truly indispensable resource to all architectural students and practitioners.

Vincent NG, JP
President
The Hong Kong Institute of Architects
November 2015

Chapter 1

General Introduction to Building Construction in Hong Kong

香港建築簡介

Wong Wah Sang 黃華生

> Much as the trapezoidal shape of the East Building's site had generated its triangular design motif, the compelling diagonals of the Bank of China were intimately related to its aesthetics. Rather than leave the roofs of the ascending shafts flat, as might have been expected, Pei set them at an angle, adding to the sense of thrust as the building rose. The skin was to be reflective glass. In true Modernist tradition, Pei chose to express the structural members that met the skin by highlighting them with aluminium cladding, creating facades of boxed Xs. At seventy stories, the tower would be the tallest building in the world, outside the United States, and its strikingly abstract form—topped with a pair of broadcast masts—would make a dramatic vertical gesture in the heart of the city.
>
> —Carter Wiseman, *I. M. Pei: A Profile in American Architecture*

In the late 1980s, people working in Central witnessed the construction of I. M. Pei's Bank of China Building in the non-Hong Kong-style construction method of using structural steel. This building with the 'trunk of a bamboo' metaphor is an example of continuous new technology being brought into the building industry, giving inspiration for Hong Kong architects. The 370 m height of the building is recorded as the highest in Hong Kong, offering a challenge to local architects.

Subsequently in 1992, the completion of Central Plaza, 18 Harbour Road, another corporate-looking office building became the tallest building in Hong Kong. And in 2010, another record was set by the 108-storey International Commerce Centre, 484 m high. Such are the continuous changes and impact that make Hong Kong construction so dynamic and interesting.

> 運用三角的意念於中國銀行大廈的設計，正好和斜形支架結構作了個和諧的組合。同時擺脫以往平平坦坦的頂部設計，貝聿銘的建築物造型配合了不同的取向和角度，並且在每個平面之外，披上一身反光的玻璃幕牆。在現代主義的傳統影響下，貝聿銘完全將建築物的結構顯露出來，利用鋁合金板和玻璃牆，成為整體的盒子形設計。整座建築物共七十層高，將會是美國之外最高的建築物了。超創意的靈感想像，還有，它在屋頂的一對巨型天線，成為市中心戲劇性的直立姿態。
>
> —Carter Wiseman, *I. M. Pei: A Profile in American Architecture*

1980 年後期，我們在中環看到中國銀行大廈的建築過程——承重鋼鐵的結構建築法，並非一般香港式的釘板模、紮鐵、混凝土的方法。這比喻為「竹節」的建築，將新科技引進，也給予香港建築業一個嶄新的啟示和開始。全幢大廈高 370 米，是高廈設計上的一個新指標。其後 1992 年在灣仔海旁落成的中環廣場，更成為另一項高廈的紀錄。再後 2010 年，108 層的環球貿易廣場，高 484 米，創下另一香港高廈的紀錄。

Construction speed

Construction speed is of prime importance in the Hong Kong building process, even outweighing quality. 'Time is money' is the slogan for the rich developers who are continuously inserting buildings to reshape Hong Kong's skyline. The amazing speed of construction is as fast as three to four days per concreting cycle for a typical floor. Large housing estates in Laguna City of Cha Kwo Ling and the residential towers in Kingswood Estate, Tin Shui Wai, at a four-day

cycle are good examples of local construction speed. Citibank Plaza in Central went up at a three-day cycle.

A review of the high cost of land explains the emphasis on time. For example, the particular site in Wanchai for the tallest office building was acquired at a government auction on 25 January 1989, at HK$3,350,000,000 or HK$460,000 per m^2 site area. Interest on the cost of the land alone amounted to HK$918,000 per day at the prime rate of 10%. This would be enough pressure to produce building very fast (at a four-day cycle per floor). Subsequently in 2016, a business site, NKIL no. 6505, 7728 m^2, at Cheung Sha Wan, was sold at HK$7,794.38 million, about HK$1 million per m^2.

Small site at Queen's Road Central with narrow frontage, equivalent to the width of a van

建築工程速度

在香港，建築工程中最重要的考慮因素是時間，其次才談到質素與品質標準。俗語云：「時間即是金錢」，是許多發展商的金句，他們不斷在香港擠壓出高廈，重組香港的天際線。一般來說，普通的一層樓面建築，從釘板到澆灌混凝土，可以快至三至四天的時間，就以大型屋邨如茶果嶺的麗港城、天水圍的嘉湖山莊等，都是以四天的建築週期速度興建的。在中區的萬國寶通廣場甚至可達成三天的建築週期。高地價正好解釋時間的重要性。例如在灣仔 1989 年買入的一幅地的地價為三十三億五千萬元或每平方米四十六萬元。地價的息口計算已為每日九十一萬八千萬元。這因素已足夠壓力去推動一「速成」建築。及後 2016 年，一幅在長沙灣的商業用地，NKIL no. 6505, 7728 平方米，以約七十八億元成交，每平方米地價為一百萬元。

Vertical extension at Sun Hung Kai Centre

Statutory restraints

Again due to the high land prices, developers and architects have constantly worked their way through legal restrictions (basically the Building Ordinance) to fish for possible developable areas. As example is the addition of top floors to the Sun Hung Kai Centre in Wanchai. This existing 42-storey building has been served by pedestrian walkways at the first-floor level. With precedent reference projects, application to the Building Ordinance Office was made for the dedication to the public of these first-floor pedestrian walkways and some ground floor public areas. The application was approved, and consequently a bonus floor area was added as the top seven floors to the existing building. A new category of design was opened up: the construction of a structure on top of an existing building when the building was still in operation. Another interesting phenomenon for this project is the conversion of existing lift shafts to accommodate double-decker lifts to meet increased passenger loading.

Just as difficult with large sites are small sites within the Central business district, say, the sort of 'one number' sites at Queen's Road Central.

法例規限

由於香港的土地價值昂貴，發展商都在法例規限的容許下，爭取更多的發展面積。這裏不妨以灣仔海旁的新鴻基中心作例子。發展商根據附近的同類發展，再向屋宇地政署申請，重新把一樓的行人天橋界定為公眾地方。而根據發展準則的案例，業主獲批准增加可發展的面積。這樣的

Kingswood Estate in Tin Shui Wai

發展或許可帶來新的設計方案。然而在四十二層樓高之上再加七層的面積，建築師需特別設計雙層電梯的方案來應付增加的運輸量。面積較小的發展地盤，比許多大規模的地盤施工更困難。沿著香港皇后大道中，便有著許多窄小而且只有一個地段編號的地盤。

Tradition

Though technology may be more advanced, and buildings are designed to be more 'intelligent', the average Hong Kong building still employs a lot of labour-intensive trades. Bamboo scaffolding, plywood formwork, spatterdash on concrete surfaces, cutting of reinforcement bars, sawing of timber planks, spray painting, hanging up mosaic tiles, etc. all are familiar scenes on a Hong Kong construction site. Similar techniques are observed in construction sites in South-East Asia, such as Singapore and Malaysia.

Not to be separated from the tradition is Lu Pan (魯班), the patron saint of Chinese builders and contractors. His festival, the 13th day of the 6th month in the Chinese calendar, is always marked with celebrations—dining, drinking, and gambling by the contractors. A tribute can be made to Lu Pan Temple, located in Ching Lin Terrace at Kennedy Town on Hong Kong Island.

傳 統

雖然現代科技不斷改進和發展，東南亞區如星加坡、馬來西亞和香港的建築業，仍以勞動工人為主。故此，在一般香港建築地盤，仍然可以見到如蓋搭竹棚、釘木板、撒沙、拆鐵板、鋸木、噴漆、鋪砌紙皮石等工序。魯班被譽為中國工匠師祖。每年農曆六月十三日，所有建築從業員都會舉行特別的慶祝活動。而位於堅尼地城青蓮臺就建立了一座魯班先師廟。

Cost of skilled labour in March 2016 (information extracted from Wages and Labour Costs Statistics Section (1), Census and Statistics Department)
2016年3月的專業技術工資表 (資料摘取自政府統計處工資及勞工成本統計組 [一])

Trade (行業)	Cost per day (HK$) (每日工資港元$)
Setting out (開線、測量)	1399.1
Formwork (木板)	1949.6
Steelwork (紮鐵)	1996.5
Concreting (落石屎工)	1902.25
Plaster, tiling (泥水、磚瓦)	1221.4
Carpenter (木匠)	1192.4
Painting (油漆)	1141
Scaffolding worker (塔棚工人)	1748.8
Unskilled labour (非專業技工)	920.9

Lu Pan Temple

Celebrations at the Lu Pan Temple on 13th day of the 6th moon: the Lu Pan Festival

Training Centre at Aberdeen with brickwork, plasterwork, and carpentry

Labour for the construction industry

Traditionally, construction workers are mainly from China. Some work, such as reinforcement work, requires young and strong, while other work, such as joinery and painting, require older and more experienced workers.

The Construction Industry Training Authority (CITA), established in 1975, was amalgamated with the Construction Industry Council (CIC) in 2007. The functions of CITA in training local workers has been taken over by the Construction Industry Training Board (CITB) under CIC.

Basic craft courses in the CIC Training Academy include:

Two-year courses:

1. Bricklaying, plastering, and tiling
2. Carpentry and joinery
3. Painting, decorating, and sign-writing
4. Plumbing and pipe-fitting
5. Marble-laying
6 Metal work

One-year courses:

1. Construction scaffolding work
2. Construction plant maintenance and repairs
3. Electrical installation

There is practical training in workshops and classroom lectures for trainees, without admission and tuition charges. During training, each trainee receives a basic monthly allowance of around HK$1,000. There is also a special allowance for site practice, in order to attract people to the construction industry.

建築工程資源

一般建築工程項目中需要勞動的工種如紮鐵等，都由年青和健壯的工人負責；而部份講求技術的工種（諸如木工、油漆等），則多半是以中年且經驗豐富的工人為主。除了由中國內地輸入的勞工之外，建造業訓練局於 1975 年成立，2008 年該局合併至建造業議會，其下設的建造業訓練委員會負責培訓本地建築工程的專門技術人才。

建造業議會訓練學院所教授的課程包括：

兩年制課程：

1. 泥水粉飾科
2. 粗細木工科
3. 油漆粉飾科
4. 水喉潔具科
5. 雲石裝飾科
6. 金屬工藝科

一年制課程：

1. 建造棚架科
2. 機械維修科
3. 電器裝置科

學徒均可參與實際訓練工作坊和課室授課，且無需交付學費。每名學徒在受訓期間都可取得每月津貼。地盤實習訓練還可以得到特別津貼，以鼓勵更多人從事建造行業。

New frontiers in construction

'Sky City 1000', a 1000 m tall super tower conceived as a vertical composite urban community, was proposed in Japan in 1989. Concave layered structures, referred to as space plateaus and realized as artificial terraces, surrounding a recreational/communal atrium were proposed. A 'conic shell structure' instead of conventional columns and beams was also proposed. Composite panels made of carbon fibre, stronger and lighter than reinforced concrete, were proposed for use in construction. High-tech construction using robots was effective in overcoming labour shortage.

Three-storey elevators (triple-deckers) were proposed to connect each space plateau. Spiral monorails were proposed to circulate between space plateaus.

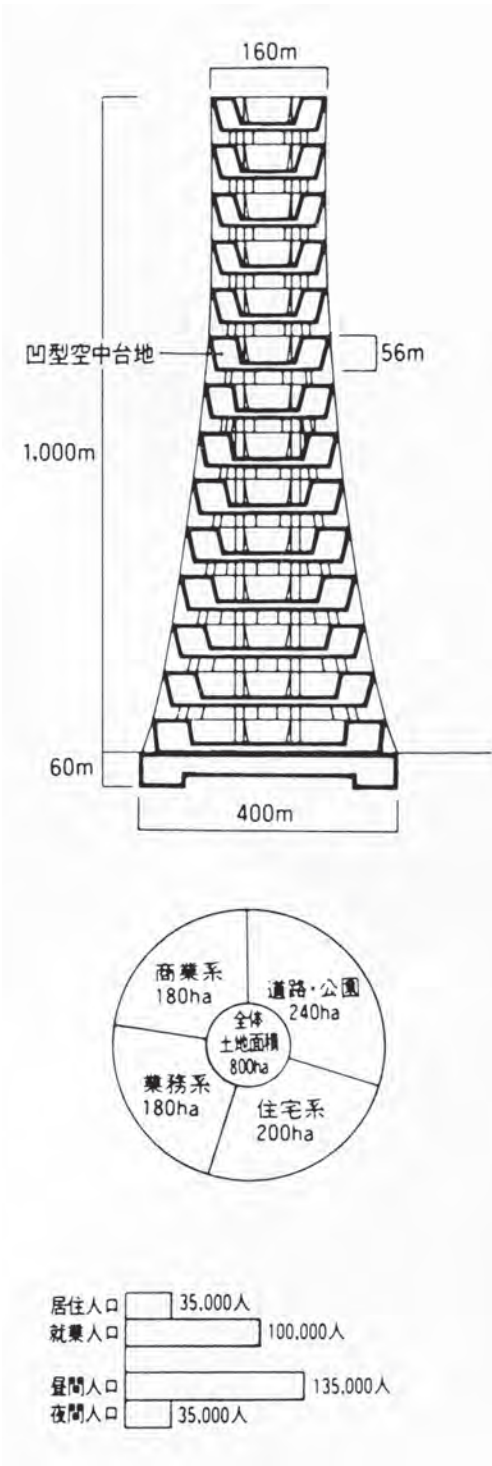
If completed, 'Sky City 1000' would accommodate 35,000 residents and provide office space for 100,000 people. The total construction period was estimated to be 14 years.

The 'Sky City 1000' concept was proposed in response to high land prices in Tokyo (as high as ¥50 million per m^2) and the overcrowding that was destroying the local environment. Subsequently in 1995, the Japanese proposed a 4 km high megastructure, X-seed 4000, that looked like Mount Fuji. With similar environmental issues, Hong Kong may need to come up with new ideas to tackle future threats that bring both problems and opportunities for innovative developers, architects, engineers, and contractors.

建築的新紀元

「天空之城 1000」是日本在 1989 年所構思的 1,000 米摩天高向城堡。從畢直的軸線作座標轉出的圓形層面結構，成為每一組的空間平原，並作為中間的休憩/商業中庭，而錐型總結構取代傳統的柱和樑。所運用的合成纖維板，亦比傳統的混凝土更堅固和輕巧。同時，還配合多功能的機械操作，解決勞工短缺的問題。三層的電梯把「空間平原」連接起來，旋轉單軌鐵路亦在空間平原中穿梭往來。據估計此項「天空之城 1000」要花十四年的時間興建，建成後，將提供三萬五千個住宅單位，十萬名就業者的辦公室空間。

日本所構想的「天空之城 1000」設計，及後來 1995 年的 X-seed 4000，四公里高，形態像富士山的超級結構，目的是解決由於日益昂貴的土地而構成的密集空間，以及因此引致許多的環境污染問題。香港面對同樣的環境問題，亦應該提出創意理念，為未來發展，同時可為發展商、建築師、工程師和承建商提供創新的機會。



'Sky City 1000': a hypothetical architectural concept in Japan announced in 1989

Chapter 2

Trades of Materials and Technology

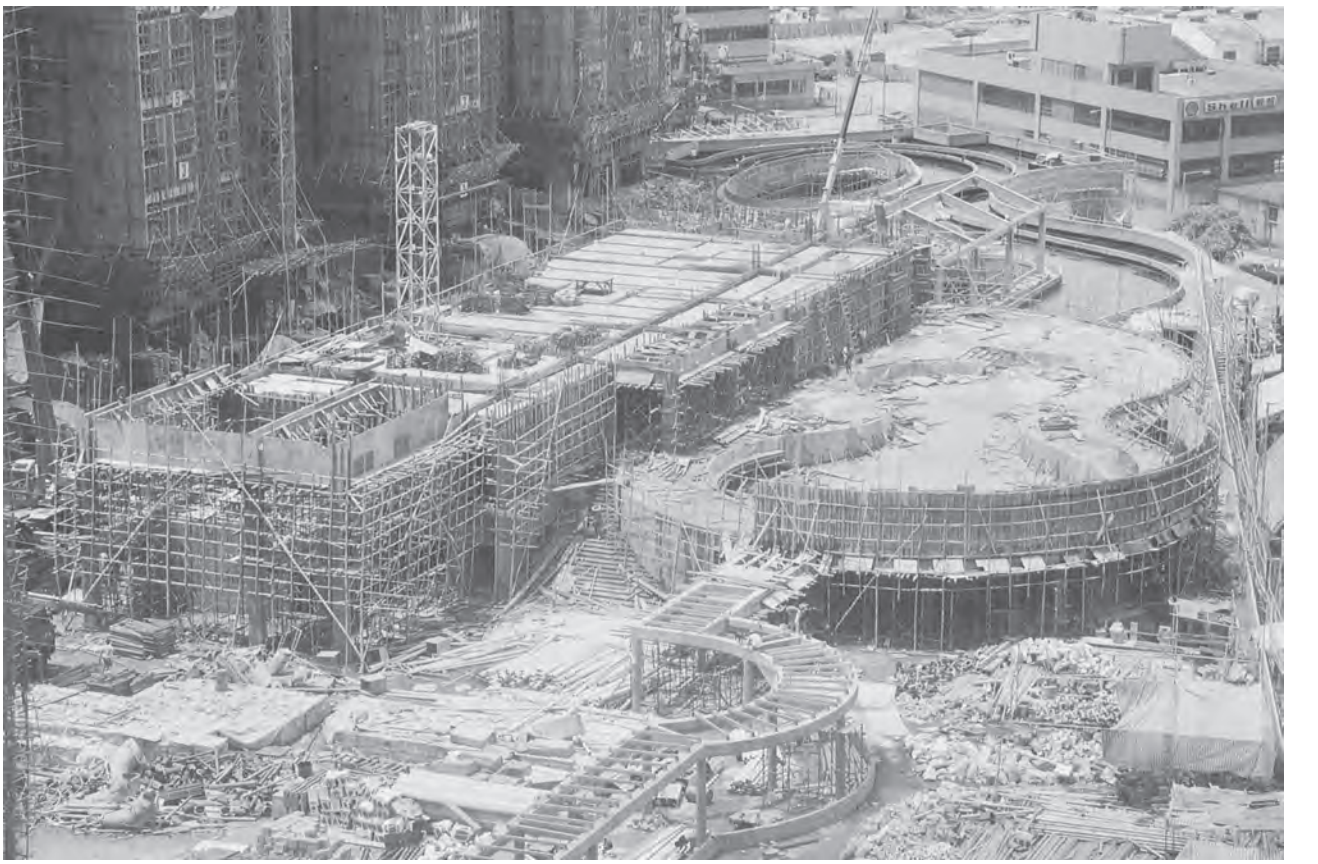
工料的類別及技術

Wong Wah Sang 黃華生

2.1

Preliminaries

整體施工預備工作



Construction of a tower

Preliminaries usually form the first section of the specifications, which is part of the tender document and will subsequently become part of the contract document. Items included in the preliminaries are:

1. Form of contract
2. Definition of terms
3. British standards and equivalent standard
4. Manufacturer's recommendations
5. Government regulations
6. General obligations
7. Temporary works and services
8. Administration, insurance, and attendance
9. Materials and workmanship

整體施工預備工作是招標文件中有關訂定規範的第一個章節部份，當協定達成之後，有關方面正式簽署文件和合同，便成為正式的合同書，同時具有法律效力。施工整體預備工作包括：

(1) 合同條款
(2) 名稱的定義
(3) 英國制度指標和國際認可的標準
(4) 製造商的建議
(5) 政府法律條例及標準
(6) 一般須遵守的規範
(7) 臨時工程工作及臨時水電設備
(8) 行政費、保險項目及其他
(9) 物料準則及工藝規格

Murray Building, where the Building Authority locates

Contract, standards, and regulations

The Standard Form of *Building Contracts: Agreement and Schedule of Conditions of Buildings Contract for Use in Hong Kong* (with or without quantities), published by the Hong Kong Institute of Architects, Hong Kong Institute of Construction Managers, and the Hong Kong Institute of Surveyors in 1976, is the basis to govern the execution of the construction work for the past four decades. This was updated in 2005 to deal with the new period in the construction industry. The latter version was written in simple English, with shorter paragraphs and subheadings for easy reading. New clauses were added to protect both employers and contractors. In addition, legal terms were more clearly defined for better understanding.

For government projects, a contract called 'General Conditions of Contract for Term Contract for Building Works' is issued by the Development Bureau.

合同、規格及法律條例

1976 年由香港建築師學會、香港營造師學會及香港測量師學會出版的《香港建築合約條例及規格》，是過去數十年作為監管私營發展建築商從事建築工程的基本法律文件。為了迎合建造業的新時代，2005 年修訂了新版。新版用簡潔的英文撰寫，輔以短段落和副標題，令條文變得更加易懂。新增的條款適用於同時保護發展商和建造承包商，且定義清晰明瞭。

至於政府工程，一般情況下使用的建造合同，則由發展局發出的文件為依據。

British Standards and Codes of Practice are available from the British Standards Institution (www.bsigroup.com). These include all amendments, revisions, and standards superseding the standards listed. The British standards are available for inspection at the following locations in Hong Kong:

1. Hong Kong Standards and Testing Centre
2. Main Library of the University of Hong Kong
3. Works Branch Library, Murray Building
4. Urban Council Yau Ma Tei Library, Kowloon

Government regulations for construction: Buildings Ordinance (Chapter 123) consolidates regulations such as the Building (Administration) Regulations, the Building (Planning) Regulations, and the Building (Construction) Regulations. Both the authorized person and the registered contractor have a duty to supervise the building works, notify the Building Authority of any contravention of regulations, and comply with the ordinance in general. The difference is that the authorized person will take periodic supervision, but the registered contractor will take continuous supervision of the building works. Once the authorized person has submitted Form BA4 and the registered contractor has submitted Form BA10, the legal obligations are sustained.

Furthermore, as the design and construction of buildings becomes more complex, it is necessary to exercise closer supervision during construction. Section 17 of the Buildings Ordinance provides that conditions may be imposed when approval of plans or consent to commence buildings works is given; qualified supervision is required at certain stages of construction or for some particular operations.

英國制度指標和實際工程規格，則由英國國家標準局制定。當中包括最新的修訂和內容。在香港可供查詢的地方包括：

(1) 香港品質及測試中心
(2) 香港大學圖書館
(3) 美利大廈的拓展署圖書中心
(4) 九龍油麻地市政局圖書館

政府訂定的建築物條例（第 123 章）包括許多有關行政、計劃、施工等法例條文細節。認可人士及註冊承建商需監察建築地盤施工的工程，履行責任知會建築事務監督有關非法的事項、工程。認可人士及註冊承建商在監察工程的責任分別，後者必須在工程期間作全面監察，而認可人士要定期監察該項工程是否遵守一切法律的規格和準則。在預備施工的地盤，認可人士必須呈交表格 BA4，而承建商亦應於開工前呈交表格 BA10，申請作為地盤工程的負責人。

Setting out

General obligations

General obligations include setting out on the site works, compliance with safety regulations as required by the Labour Department and the Industrial Safety Training Centre, maintenance of roads, and protecting or shoring up adjoining properties.

The site boundary can be set out by the Government Survey Office with critical marks identified with marking nails on site. These nails must be properly protected by the contractors after handing over to the landowner from the government. It is advisable to use lending points using triangulation to be marked for easy location of the original setting out points. Levels are often referred to as Principle Datum (PD). Information can be obtained from the nearest government benchmarks. Inaccuracy of setting out can lead to abortive work or delay in progress. Maintenance of roads includes cleaning the wheels and underside of lorries and making sure that they are free of earth before they leave the site, filtering earth, discharging concrete water into a public sewer, and securely stacking rock or debris on lorries to avoid dislodging and falling onto public roads. In some cases, limitation to the loading of vehicular traffic using the public roads has to be observed.

Shoring against adjacent properties or roads is in accordance with the approved shoring plans. Shoring systems such as flying shore, raking shore, and dead shore may be used. Monitoring devices for recording any settlement may also be required. These are all directed for the general safety of building construction.

一般法則規格

一般非列明法則，包括在工作地盤進行量度及定界線，遵守一切由勞工處以及建築業管理局等訂定的規格，地盤附近的公共地面維修、保護及鄰近建築物的臨時支撐等。

地盤的界線由政府測量工程處負責，經測量後再以鐵釘直插於地上作永久測量標誌。承建商需負責保護及以此界點作地盤的範圍。每個定點可用普通的三角幾何學來制定借點及計算實際的方位。地面的平水

Construction site at Laguna City, Kwun Tong

Various hoarding designs, Kingswood Estate in Tin Shui Wai

通常以平面為準則，可以利用附近政府所定的記號量度。準確的定界和量度可避免工程錯誤或延遲。承建商亦需負責地盤附近的地面清潔和安全問題。所有進出地盤的泥頭車，必須清洗妥當，才不易沾滿地面的沙泥；必須每天清除堆積的混凝土和沙石等雜物，避免阻礙公眾通道。支撐隔鄰建築結構的方案，必須經建築事務監督批核。支撐結構方法可分為：(1) 懸空支撐（飛頂）；(2) 斜支撐（斜頂）；(3) 固牆豎木（死頂）。

施工期間，亦須注意四周的結構是否影響到鄰近的建築物。專門的測試儀器和方法，可以提供定期報告和防止地盤意外。

Temporary works and services

Temporary works and services include hoardings and fencing, scaffolding and signboards, temporary offices and storage sheds, contractor's sheds and guards, and temporary water and electricity supply.

Hoardings and fencing are required to be constructed before the commencement of works. An authorized person is required to submit Form BA 19 and hoarding plans to the Building Authority in order to receive a Hoarding Permit (Form BD 109).

The Hoarding Permit requires the permittee to inform the corresponding electrical company and the PCCW-HKT Telephone Limited (formerly the Hong Kong Telephone Company) 72 hours before commencement of work to ensure that no cable will be affected. An Excavation Permit is also required from the chief engineer, Highways Office, before opening up the footpath or carriageway. Timber or steel structures can be used where appropriate. The project signboards will include English and Chinese, the artist's impressions, or graphics and logos. The contractor must submit Form BA18 together with construction details to apply for a contractor's shed. Contractors prefer containers for temporary offices on larger sites.

Temporary water can be applied and obtained via metered supply from the Water Authority. Temporary electricity is also available from the electric company upon application, the amount of which will depend on the actual necessity.

臨時工作及設施

所有臨時工作及設施包括圍板、搭棚、水牌、臨時建築地盤、物料貯存室、承建商的地盤辦公室、看更房、臨時水電等。

保護地盤的圍街板、有蓋行人道或門架，必須在屋宇署同意展開工程前建造完成。

認可人士必須呈交表格 BA19 和圖紙給屋宇署，以取得工程認可（表格 BD109）。同時亦須向路政署申請掘路紙，才可以在地盤界線之外進行任何挖掘的工作。在建築事務監督發出圍街板的開工紙的同時，更要在 72 小時之前知會香港電燈公司或中華電力公司以及相關電訊公司，確認所有的電源已經截斷。木板和鋼鐵可以用作興建圍街板。通常在當眼的地方會張貼有關該項發展的中英文基本資料，包括承建商、認可人士的公司名稱、其他參與建築計劃的顧問及業主等。

如承建商需建臨時辦事處，必須向建築事務監督入紙申請。在一般大型的建築地盤，承建商多會以貨櫃箱作為臨時工作地方。至於臨時水電可分別向水務署和電力公司申請。

Administration, insurance, and attendance

Regular site meetings are held to monitor the progress of different trades and to coordinate various subcontractors.

Insurance means third-party insurance, employees' compensation insurance, contractor's all-risk insurance, and surety bonds.

Attendance for the nominated subcontractors, nominated suppliers, specialist contractors, government departments, and public utility companies are provided according to the following:

1. Use of plant, ladders, scaffolding, etc. as erected by the contractor. There is no obligation to retain such facilities longer than the contractor's own use.
2. Provision of space and lock-up rooms for storage of materials and tools.
3. Temporary water and electric supply.
4. Guards to safeguard the site.
5. Coordination with the contractor's programme of works.
6. Coordination with other trades such as provision of openings and chases, cuttings.
7. Cleaning and clearing away debris.

行政費、保險項目及其他

定期的地盤會議，能監管不同項目的工作進度以及協調各項目承建商的合作問題。保險項目泛指第三者保險、僱員勞工保險、承建商意外賠償保險及擔保金。

指定的其他項目承建商、物料供應商、特別項目顧問、政府部門、公共設施公司等可共同享有以下的設施，包括：

(1) 地盤的機械、梯級、竹棚等由總承建商負責的項目，但卻絕不能超過承建商工程訂立所運用的時間；
(2) 由承建商提供的貯物空間；
(3) 臨時水電的設備；
(4) 地盤看更；
(5) 配合承建商的施工計劃；
(6) 配合其他工作項目的施工過程；
(7) 清潔及移除一切廢料。

Materials and workmanship

In simple terms, the quality of work is required to be consistent with good building practice in Hong Kong and to comply with the relevant British Standards (BS) or Codes of Practices (CP) unless otherwise specified. Sometimes it is written in the specifications that quality must in every respect be to the satisfaction of the architect, giving the architect power to reject any 'unsatisfactory' work.

Submissions of samples, execution of mock-up, and preparation of shop drawings are all good practice for understanding between all parties before actual construction work begins.

Traditional bamboo scaffolding

Cost of preliminaries

Some of the preliminaries items can usually be priced between 5% and 10% of the total contract sum.

An example is quoted for the breakdown of different trades of a cost estimate for an office building and is tabulated below:

物料和施工質素

概括地說，優質的工作是必須符合香港的建築規範，如英國的國際性標準或其他同等的指標。有時亦可以把要求的準則詳細列明，但要符合建築師的要求和指示。在合同條文中已列明建築師有權批核承建商的工作質素。

所謂優質的工作，包括了物料的選擇、提供施工圖讓建築師批閱，以及其他項目承包商或顧問的合作等問題細節。

施工整體預備工作費用

有些施工整體預備工作項目在初步預算表中，可以明確地訂定費用和價錢。預備工作費用通常佔總建築費約百分之五至十左右。以下是一座商廈建築費用的明細計算表：

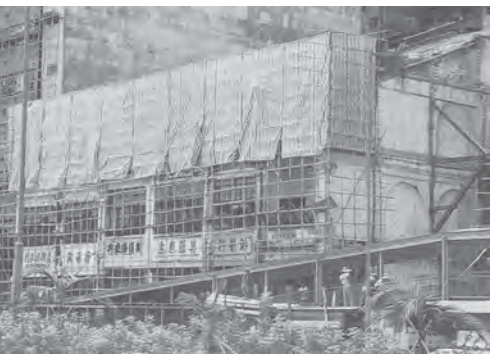
Proportioning of cost estimated for an office building of about 12,000 m^2 floor area
初步估算一座約12,000平方米商廈建築費用明細

Section (項目)	% Cost (費用百分比)
1. Foundation 地基工程	2.8%
2. Substructure 地面以下的結構工程	1.3%
3. Superstructure 地面以上的結構工程	11.9%
4. Facade finishes 大廈外牆的物料	25.8%
5. Plumbing and drainage 渠務工程	1.6%
6. Architectural works 建築工程	16.5%
7. External works and landscaping 園林及周邊工程	0.4%
8. Preliminaries 前期施工	6.5%
9. Electrical 電器	5.1%
10. Air-conditioning 空調設施	13.9%
11. Fire services 消防設施	3.2%
12. Lifts and escalators 電梯和電動升降電梯	6.9%
13. Contingencies 預備費用	4.1%
Total 合共	100%

2.2

Demolition and Excavation Works

拆樓及挖掘工程



Commencement of demolition for some old tenement houses. Erection of screens and scaffolding.

Heavy machines imposing great loads on old buildings may not be permitted for demolition.

Preparation work

Before the commencement of demolition, a thorough survey is done and available drawings of structures are examined.

The authorized architect will arrange for disconnection of utilities services including gas, electricity, water, and telephone. Any fitting attached to the building in connection with tramway services, street lighting, electricity or other services is removed. Adjacent road signs, parking meters, hawker stalls, street lighting, etc., affected by the demolition are removed by the relevant government departments.

Apart from the hoarding, the contractor will erect at walls abutting any street, fans, or catch platforms at the first floor level or at levels as that may be necessary to prevent materials from falling to the gound. Dust screens are required to cover the whole wall area. Sewer and drainage connections are sealed, and glazed sashes and doors are removed before breaking down the structures. If necessary, shoring may be erected to prevent the accidental collapse of any part of the building or any adjoining building.

預備工作

樓宇拆卸工程進行前，應先檢查該樓宇及鄰近樓宇的結構和安全等問題。

政府認可的專業人士要負責有關拆樓前所需要的準備工作，包括通知有關部門暫停供應公共設施，如水、電、煤氣、電話等外，還要留意其他有關的設施，如電車服務、路燈、道路指示牌、泊車位、小販檔位等。

除了圍街板外，承建商需要在地盤向街的地方，由一樓起興建承接平台，以防範拆樓時跌落的沙石和雜物。此外，要在被拆卸樓宇的周圍架起防塵網。而有關渠務、水管等當然都要完全封閉妥當。至於門、窗及玻璃，都必須先拆除才可以進行其他的拆卸工程。

有時，還需要安裝支撐架構來保護鄰近的建築物，以避免因拆樓工程而導致鄰近樓宇倒塌。

Demolition works

The demolition works must be carried out under the supervision of an experienced person and the required procedures as stated in APP21. A notice in Form BA20 stating the name of the person in charge must be posted in a

prominent position on the demolition site. Competent workers are employed for the demolition of the structural frame, roof, staircase of a building, areas with risk of collapse, and for the cutting-up of structures.

It is essential that debris or materials not accumulate on floors so that floors are overloaded, as floors are not designed for such heavy loads. Great pressure exerted on adjoining buildings and on hoardings is not desirable either.

Some demolition methods, such as the use of a crane and a hammer, are considered to pose unacceptable risks or impose heavy loads on the building and are therefore unsuitable in certain circumstances.

In the demolition of buildings containing asbestos-based products, special care is exercised. The area concerned is cut off by dust-proof screens, and all workers must wear half-mask dust respirators.

Timber raking shore

拆樓工程

拆樓工程必須在經驗豐富的工程人員監管下進行，同時要履行《認可人士及註冊結構工程師作業備考》APP21 條內所說明的一切工作形式。尤其是當要拆除樓層的結構架、樓梯，或者是該部份有倒塌的危險，又或是涉及結構等的項目，都要聘請有經驗的技工。因此，在每個拆樓工程的地盤，都需要在當眼的地方張貼屋宇署表格 BA20，清楚列明地盤監管人的姓名資料。

當每層的拆卸物堆積而構成層面的承重力增加，或使圍街板和鄰近的建築物構成沉重的壓力，都是很危險的，因此，要定時把現場的堆積物移離。

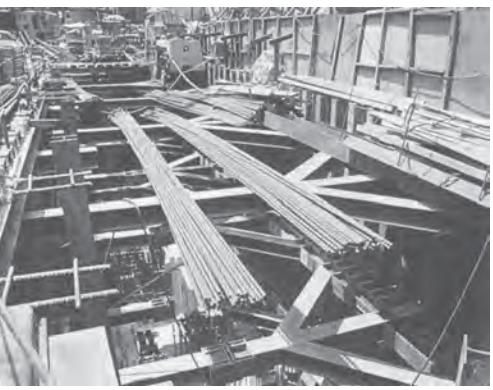
有些拆樓方法，需運用到起重機、鐵槌等，會被列為危險類別。除非在不得已的情況下，否則不應考慮。

如拆樓工作涉及含「石棉」成份的建築物料，更需加倍謹慎小心。勞工處及環境保護署會要求承建商提交拆卸石棉工程的方法及處理方式，而該地方更要以防塵帳幕四面包攏起來，所有的工人則要配戴氧氣面罩。

Timber flying shore

Steel sheet piling for basement excavation

Timber planking and strutting for trench excavation



Steel strutting for basement excavation

Excavation

Excavation includes removal of the existing old foundation, cutting off pile heads to the required level, and removing and legally disposing of all surplus materials.

Planking, strutting, or shoring may be required to support the sides of the excavation. Work is carried out to prevent erosion or slips. Working faces are limited to safe slopes and height. Material must not be stockpiled to cause a landslide, and authorized persons, registered structural engineers, are required to take adequate precautions to ensure public safety whenever necessary during excavation as part of the work as stated in APP57.

It is essential that earthwork be sealed up after each day's work or when heavy rain is expected. Cutting is planned to prevent ponding. Temporary water courses or channels are provided to discharge the water, usually through a sand trap before going into permanent drains.

挖掘工程

挖掘工程包括：

(1) 清除原有的地基；
(2) 切斷樁頭到指定水平；
(3) 清除所有剩餘的雜物。

在挖掘地方的兩旁，需要以木板或其他支撐方法來預防兩旁的結構倒塌。工作的範圍受安全高度和斜面所限制，挖掘的雜物不能堆積於任何地方而引致山泥傾瀉。而各認可人士及有關工程師應根據《認可人士及註冊結構工程師作業備考》APP57 所規定，作出適當的設計以確保公眾安全。

每天挖掘工程完成後，要小心把挖掘的地方覆蓋妥當。加設臨時水渠可疏導因工程或滂沱大雨後所引致的積水，而每個疏水導口都要裝置隔沙井，才可以接駁公共渠道。

Dewatering

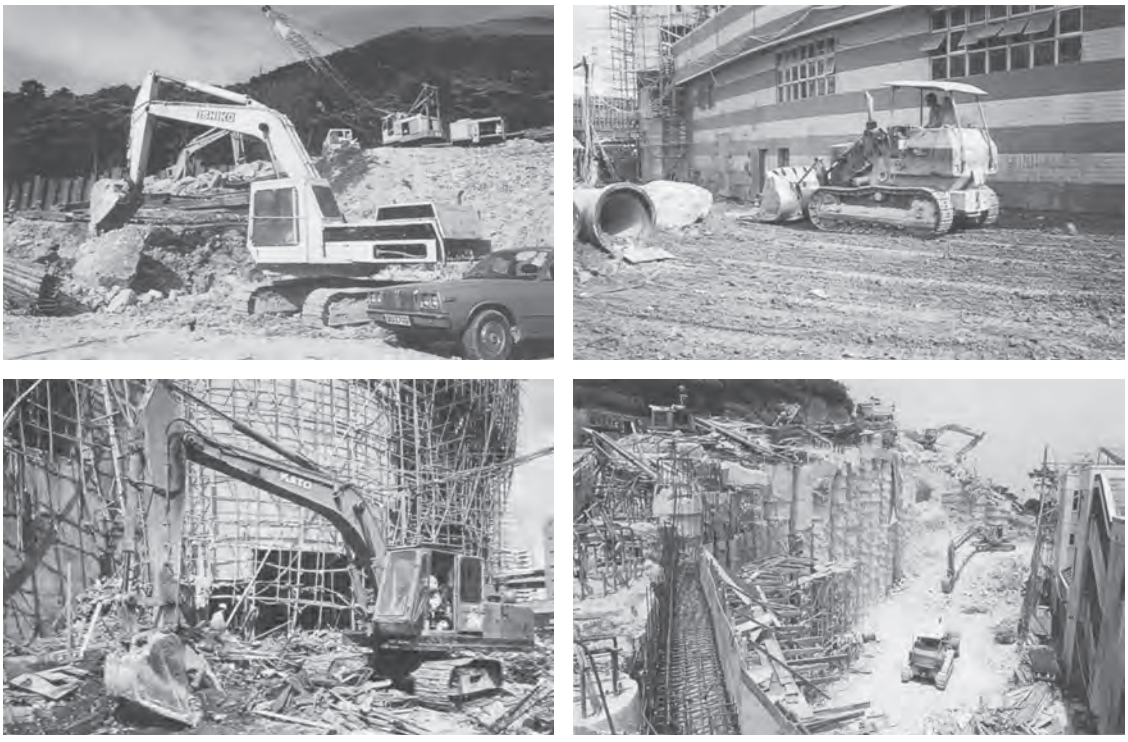
In constructing foundations and basement excavations, dewatering may be required to achieve a dry, workable base, during which precautionary measures are taken to avoid impairing the stability and causing undue settlement of any adjoining buildings, streets, and land. Ground treatment such as grouting may be necessary.

In connection with dewatering, adjoining foundation details have to be studied together with site investigation report. All the related information, plans, reports, and assessments should submit to the Building Department. An assessment of dewatering effects is monitored by piezometric and settlement records. Limiting criteria for movements and groundwater pressures are set up. If these values are reached, action such as shoring or underpinning may have to be taken.

抽水工程

如在地下層或地基進行挖掘工程，都需要抽取地下水，以使地盤乾爽，方便工作。不過，抽水工作要有適當的保護，以免影響鄰近水位以及建築物的地基。一般地面的處理方法如灌漿等，都可以使鄰近水位保持不變。

設計抽水工程計劃時，須要一併研究鄰近地基結構和探土報告等資料，並應向建築署提交所有相關研究的資料、記錄詳情及評估。抽水工程進行時，要定期查閱水壓計與沉陷觀察釘，觀察工程對附近地區所帶來的影響並作報告。若測度結果超過計算所定的指標，必須採取適當的應變方法，如附加支撐托等。



Earth work machines

2.16

External Work and Landscape Work

外圍工作與園境計劃

Landscaping at the Simon Fraser University, Burnaby, BC

Planting of trees along the pavement with tree grilles

Landscape work

Landscaping is often the final touch of construction work. For large sites, planting, watering, and fertilization proposals often have to be considered by the Lands Development for approval.

The subsoil used is fine-grained decomposed granite free from impurities, the general depth of which is at least 300 mm. The topsoil is a fertile layer of free-draining material of a sandy loam character made of 3:1 decomposed granite and peat moss free from grass or weed, 150 mm thick. Planting season is from April to August for best growth of plants. Preplanting fertilizer of a slow-release compound comprising nitrogen, phosphorus, and potassium (10:15:10) can be added during cultivation of soil before planting. Plants are well watered before they are removed from containers for planting. Trees may need tripod staking for support. After planting, the plants are watered thoroughly. Fibrous organic mulch 75 mm thick can then be applied.

Depending on age and size, trees are classified as seedlings, whip trees, light standard trees, standard trees, and heavy standard trees. Seedlings are one to two years old and 150 to 600 mm tall. Heavy standard trees are over four years old and over 3,500 mm high. Shrubs are transplanted seedlings or rooted cuttings with a bushy appearance. Ground cover plants are perennials with low, close growth covering the ground surface. Climbers are plants maintaining an upward growth on walls, fences, etc. Turfing is green grass free from weeds, pests, or disease. General species are carpet grass, Bermuda grass, centipede grass, and field grass.

Hydroseeding is applied on large areas or on slopes. Seed mixes contain Bermuda grass, bahid grass, rye grass, rhodes grass, weeping love grass, centipede grass, buffel grass, or a combination of these.

Seeding is usually done by spraying in damp, overcast conditions. Sprays are blended with mulch, fertilizer, and a soil-binding agent. The sprayed areas are protected from strong sunlight or heavy rain by muslin or nylon net until seeds show good germination.

園境工程

園境工作一般視為建築工程中最後的項目。在較大型的地盤裏，種植、澆灌及施肥的安排，通常都要經地政總署的批劾。

底層土壤是較微細的、不含雜質的化解麻石碎。普通的深度為最少 300 毫米。表面的泥土是營養面，含有沙底之類的滲透性物質，由 150 毫米 3：1 的化解麻石與不含細菌的菌草碎合成。最佳的種植季節在每年的四月至八月間。在未正式種植時，可在泥土面預先噴上營養合成物，其

Podium garden at the Hong Kong Convention and Exhibition Centre

Triangular motifs at the Bank of China

Plane of water at the Bank of China

Chinese-style landscape

中包含氮、磷、鉀（10：15：10）。植物離開苗箱時，必須仔細澆水。樹木要以三邊的支援架模穩固其主幹。種好的植物，必須重新澆水一次，可在上面蓋上 75 毫米的有機纖維模。

樹木類別可按其年齡及體積分為：樹苗、狹木、輕盈標準的樹木、標準樹、重型的樹木頭。樹苗生長了一至兩年，高 150 至 160 毫米不等。重型樹木生長了四年以上，高度超過 3,500 毫米。灌木由苗種或切根法培植而成，具有枝葉較燦爛的結構外觀。地被植物是矮小類的地面生長植物，攀緣植物可以附著牆身與圍牆類植物攀爬而生。草地屬不含雜草、細菌等的青草。

噴草用於較大的地方與山坡位置，工作一般在較潮濕的天氣進行。噴草混合許多不同的護根、營養料與土壤的結合料等。噴草範圍須小心保護，避免受陽光與雨水破壞，完成噴面工作後，要用尼龍布覆蓋好，直至小草發芽生長。

Roads

Large sites are frequently required to construct their own private streets (a footpath on each side) or access road (a footpath on at least one side). The planning and construction of private streets and access roads is governed by the Building (Private Streets and Access Roads) Regulations. The width of the street depends on the type of use of the area and is determined by the Building Authority. The design of the kerb radius, road junctions, gradients, horizontal curves, and vertical curves is governed by the regulations.

The carriageway is constructed of a camber of 1 in 40. The surfacing of the carriageway is generally either of the following:

1. Concrete not less than Grade III and not less than 150 mm thick laid on at least 75 mm hardcore. A 75 mm thick BRC (British Retail Consortium) mesh-reinforced wearing slab can be added on top for prolonged use.
2. Bitumen macadam not less than 75 mm thick laid on hardcore not less than 200 mm thick with a finishing coat of fine bitumen macadam not less than 25 mm thick.

Kerbstone is constructed of granite (from China) or precast Grade III concrete 150 mm wide and less than 750 mm long. The depth of kerbstone is 300 mm and is partly embedded in the ground so that the top of the kerb is between 75 mm and 175 mm above the level of the adjacent channel.

The footpath is generally surfaced with concrete not less than Grade III, at least 50 mm thick, and covered with granolithic paving not less than 12.5 mm thick. Precast concrete tile paving on a compacted grade is also acceptable. Paving tiles such as artificial granite tiles on concrete slab is another alternative. The footpath is constructed with a cross-fall towards the kerb of 1 in 40.

The road is provided with surface channels constructed of Grade III concrete not less than 150 mm thick or 300 mm wide. In cross-section, the channel is laid to a fall of 1 in 30 towards the kerb and in longitudinal sections a fall not less than 1 in 100 although 1 in 250 may be permitted in special cases.

Road markings and traffic signs also form part of the road construction system.

道 路

在大型地盤的地契裏，通常要求建築私人的「街」(兩旁有行人路) 或「路」(只須其中一邊設置行人路)。在計劃與建築時，須參照《建築物 (私家街道及通路) 規例》。街道的闊度取決於發展的用途後，再經建築事務監督批准。至於行人路面的直徑、路的分叉口、斜度、橫向弧度、轉角弧度等，都有法例依據。

Fence wall

A fence wall not less than 1.8 m high is required by the Building Authority to be constructed around the site of a building adjacent to a street or lane.

The footing of such walls is usually an L-shaped cantilever structure. If construction is of brickwork or blockwork, the thickness is 100 mm for under than 1.8 m high and 225 mm for over 1.8 m high. A length of over 2 m is provided with 225 mm^2 buttresses or piers at not more than 2 m centres.

Other construction can be of concrete, steel wire, glass block, chain link, and so on.

圍 牆

根據政府建築條例，圍牆的高度必須要在 1.8 米以上，且圍繞地段的範圍界線內。

圍牆的一般地基為簡單的 L 型懸臂式結構。由磚或混凝土磚建築，如果牆身高度為 1.8 米以內時，牆的厚度為 100 毫米；而牆身高度在 2 米以上時，須以 225 毫米厚度的方形柱墩，每 2 米的距離內加在牆身。

其他的建築用料包括混凝土、鋼線、玻璃磚和鋼鏈等。

Chapter 3

Case Studies

實例研究

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3.1

The Forum, Hong Kong, China: Curtain Wall Design

中國香港富臨閣：玻璃幕牆設計

The forum viewing from the podium

The Forum at Exchange Square was originally a three-storey retail building of concrete, which became obsolete upon completion of the new IFC shopping mall at the adjacent site. The client requested a new iconic Grade A office building surrounded by an improved outdoor public plaza connecting the footbridge and the shopping mall beyond.

This redevelopment offers a great opportunity for the architect to create a new landmark in Central. One key design consideration was the quality of public space created and the massing in response to pedestrian flow around the plaza. The final concept expressed the building as a precious urban 'gem'. The challenges of this project are of several aspects: the site constraint, limits of the existing base to carry the load, and statutory requirements.

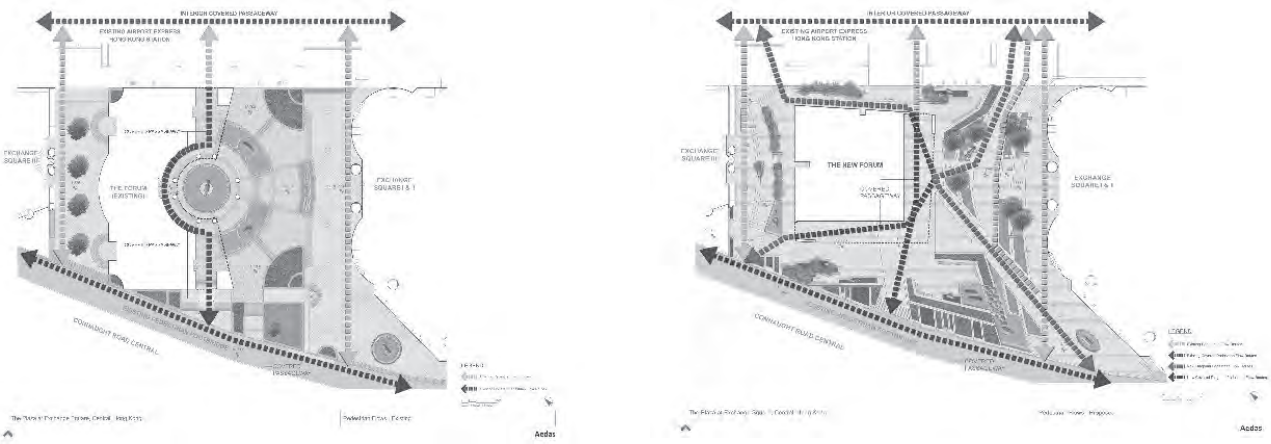
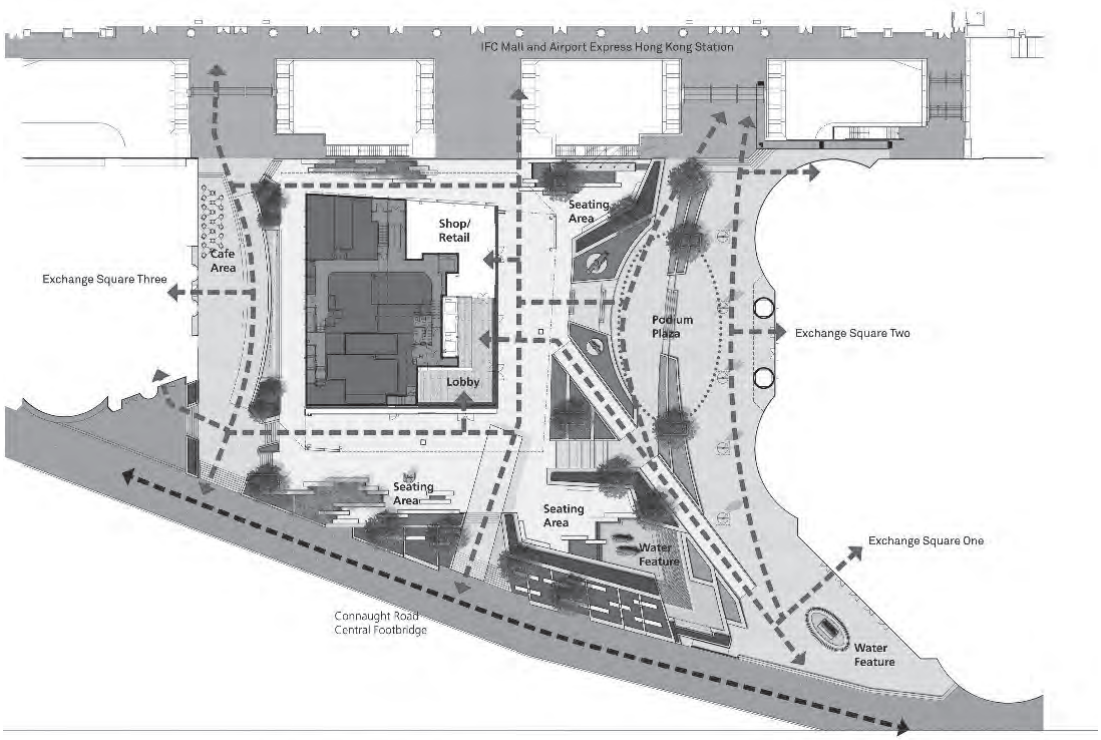


Diagram comparing the circulation pattern between the existing site force and the proposed new plan



The master layout plan for the Forum

此項目為重建交易廣場發展計劃的其中一幢大樓，原大樓是一座三層高的混凝土結構商場。在旁有新建成的大型商場，故用處比以往大大減低。項目旨在將其重建為一座五層高、更為簡潔的甲級商廈，而且更能有效地連接廣場及其他周邊建築。

富臨閣重建項目提供了最好的機會，去打造一個位於中環優越地段的新地標。建築師提出其中一個主要的考慮，就是公共空間的質素及建築的形態要如何改善附近的人流交通。最終的設計構思是將大樓視作一顆珍貴的城市寶石，項目的形態創造了一個開放的空間，切合最初的設計原則。這個項目面對幾個挑戰：場地限制、原本地基荷載限制和建築物條例要求。

Site constraints: On structural and construction aspects

The building was planned to sit on an existing concrete podium deck, which is directly above an operating Public Transport Interchange (PTI). To avoid affecting the operation of the PTI, no alteration of the existing structure was allowed. The loading capacity of the existing podium structure was a concern to the architect and engineer to cater for the new building on top.

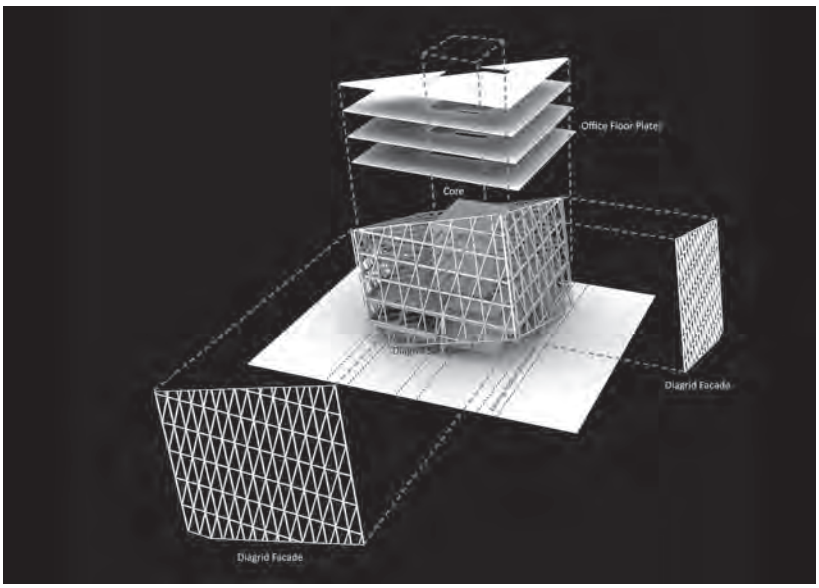
The main structural support points and the building core are strategically positioned on the original podium main girder. A lightweight steel diagrid structure was developed to distribute the loading uniformly onto the original podium structure. The nodes of the diagrid were set out to match the building floor levels to allow beams spanning between the diagrid nodes to allow for a structurally efficient design.

To avoid affecting the operation of the PTI, some of the major construction process or electrical and mechanical connection can only be planned at night, four to five hours per day. A packed programme was prepared. The construction period for the whole building was planned to be within 16 months.

場地限制：結構和建造方面

該建築規劃在現有的混凝土平台結構上，平台的底部有一個公共運輸交匯處。為了避免影響對交匯處的日常運作，現有的平台結構要保持不變，原結構的支承荷載能力是建築師和工程師需要考慮的一個關鍵問題。

最終採用了一個簡單的輕鋼斜肋結構，並將新建築的荷載平均地分佈在原有平台結構上。另一方面，為了避免影響公共運輸交匯處的運作，一些主要的工程進度及機電連接只能在晚間進行，每天只有四至五個小時。承包商和場地管理商制定了項目流程，項目建設計劃在 16 個月內完成。



An exposed diagram showing the structural system of the Forum

Diagrid system: Importance of temporary support

Differing from an ordinary column and beam structure, the diagrid system cannot stabilize itself until the steel framework is completed and therefore requires a temporary support frame. In order to release the temporary support well, a specially designed 'sand jack' is used at the interface between the temporary support and the podium deck. A sand jack is basically a steel tray filled with densely packed sand, which bears the loading from the temporary support. After the grid is completed, the steel tray is dismantled and the sand is removed bit by bit, to lower the temporary structures before they are detached last. The permanent steel structures are designed to have a certain precamber value. Upon completion of the building, the building reaches its design dead load, and the settlement of the structure brings the building precisely back to its design level.

斜肋結構架：臨時支撐的重要性

與傳統的柱梁結構不同，斜肋結構在鋼結構未完成時是不能達到自我穩固的，所以需要臨時支撐架來穩固。為了更容易的拆掉臨時支撐，特別設計的「砂箱」用於平台和臨時支撐的接口。「砂箱」是由一個裝滿砂的鋼鐵托盤組成，用來承受臨時支撐的負荷。當斜肋結構完成後，鋼鐵托盤會被拆卸。砂則會一點一點的被轉移來降低臨時結構，最終它們會被清除。最終使用的鋼結構有一定的預拱度，當建築完成時，建築達到預計的淨負荷時，就會返回設計時的特定水平。

The construction of a diagrid structural frame

Details showing the façade design

The sealant joint design

Façade design: Modular design concept

The form of the building is a gem in the landscaped plaza of Exchange Square. The tilted building form was designed to be supported by a diagrid structure for stability and running in line and integrated with the façade mullion. A unitized curtain wall system was used. Each curtain wall module is made up of two triangles which form a parallelogram shape. The modular dimension is 2.4 m × 4.5 m, which is in line with the floor-to-floor height. Much consideration was given to the size of the module to match the office modular planning grid and allowed the node of the diagrid to coincide with the floor plan.

外立面設計：模組設計概念

項目的概念是一個在交易廣場平台花園中的菱形寶石。當設計外立面時，菱形網格結構作為一個框架來承托混凝土樓板，外立面則採用單元式幕牆。每個幕牆模組是由兩個三角形組成，形成一個平行四邊形，以配合斜肋鋼結構。該模組的大小經過詳細的考慮，寬度為 2.4 米，高度則等於一個 4.5 米的樓層。

Curtain wall glass panel

The selection process of the glass for the external façade is important, as it will greatly affect the appearance of the 'gem'. The glass panel of the curtain wall is an IGU consisting of two 12 mm glass panels with a 12 mm air gap. The outermost glass is a heat-strengthened glass panel, and the inner one is a tempered-glass panel. The use of heat-strengthened glass has the advantage of better surface flatness. Also, considering the OTTV of the building, a low-e coating is used to give a lower shading coefficient to the glass. For colour, transparency, and reflectivity, a mock-up of different glass types is hoisted into the air and tilted at the exact angle of the building façade to simulate the as-built lighting and reflections for the client and the architect to select.

Mock-up for the selection of glass

For the façade, the tilting angle of the massing is aligned with the modules so that the transom and mullion can be touching each other in perfect shape.

As the architect wanted to expose the diagonal members, the transoms were concealed and the diagonal members were highlighted with aluminium capping. The gaps between the panels were not filled with gasket but with aluminium expressed. Movement was allowed in the detail design.

Construction of a composite metal deck

玻璃幕牆

玻璃的選擇非常重要，因為它在很大程度上影響到「寶石」的外表。幕牆的玻璃面板是由兩片 12 毫米厚的玻璃與 12 毫米空氣間隙組成的中空玻璃。最外層的玻璃是半鋼化玻璃，內層是全鋼化玻璃。使用半鋼化玻璃的好處是可達至更平坦的表面。此外，考慮到建築物的總熱傳送值，使用了低幅射塗層以減低玻璃的遮陽係數。體量的傾斜角實際上是與模組對齊，使得橫框和豎框以完美形狀相互接觸。

由於建築師設想構件表現出斜線，故橫樑被掩蓋，而斜構件則在外面加上鋁覆蓋。為了強調線條，面板之間隙沒有裝置墊片而凸顯了斜線鋁組件。細部設計則留意建築物的微移動。

Construction of composite deck slab

With the use of a structural steel frame, a composite steel deck was used for the floor slab system. This is a system of structural decking with profiled steel sheeting, which performs as part of the structure and a permanent left-in formwork for the slab. After installation of the deck, the reinforcement was set up and concreting followed.

鋼板加混凝土組合樓板的建造

配合鋼結構框架，樓板結構採用了鋼板加混凝土組合樓板。預製壓型鋼板成為永久性樓板的底部，然後進行鋼筋加固和混凝土澆灌。

Coordination with consultants and contractors with BIM

The construction period for the project was short and because of its steel structure, a Building Information Model (BIM) was introduced to make sure that all the architectural design, structures, and E&M services were properly coordinated. Any mistake or clashing of the service destroying the cleanliness of the building is avoided. Some of the piping, like water pipes for sprinklers, was designed to pass through the steel beams to save space, also well noted before prefabrication. All piping and routes were drawn in the 3-D model so that consultants could use the model to fine-tune the final product. With the help of the latest software, the contractor could also plan all the temporary work and safety work surrounding the site and easily show it to the client.

協調顧問和承包商的建築資訊模型

由於項目為鋼結構，加上項目建設期很短，建築資訊模型（BIM）被引入應用，以確保所有的建築設計、結構和機電設備的配合。不同組件的任何錯誤或衝突，都會破壞建築設計。譬如消防灑水器水管的管道穿越了鋼樑以節省空間，所有的管道和途徑都被繪製在三維模型上，使顧問能根據模型進行最終的微調。利用三維模型，承包商也可以用來計劃所有臨時工程和工地安全的包圍工程，並很準確地以圖像與客戶溝通。

Client:	Hongkong Land
Architect:	Aedas
Structural Engineer:	Ove Arup & Partners Hong Kong
Mechanical and Electrical Engineer:	J. Roger Preston Limited
Landscape Consultant:	Aedas Landscape
Management Contractor:	Gammon Construction Limited
Year of Completion:	2014

3.8

The French International School: External Wall and Auditorium

法國國際學校：外牆與禮堂建設

Façade of classrooms

To find a design solution that could satisfy the identity of an education system for the French community, to make use of the sloping site, and to conform to the four-storey height restriction, the architect put all the building blocks together in the form of a pinwheel generated from a sky lit central court designed as the focal point and as the place for orientation of direction to the four wings of the primary school, secondary school, administrative block, and recreational block, all interconnected by split-level open corridors.

By placing the blocks at different levels, the sloping site is fully utilized. Viewers can enjoy good scenery from almost every corner of the blocks. Even the auditorium is located in the basement to make full use of the sloping site.

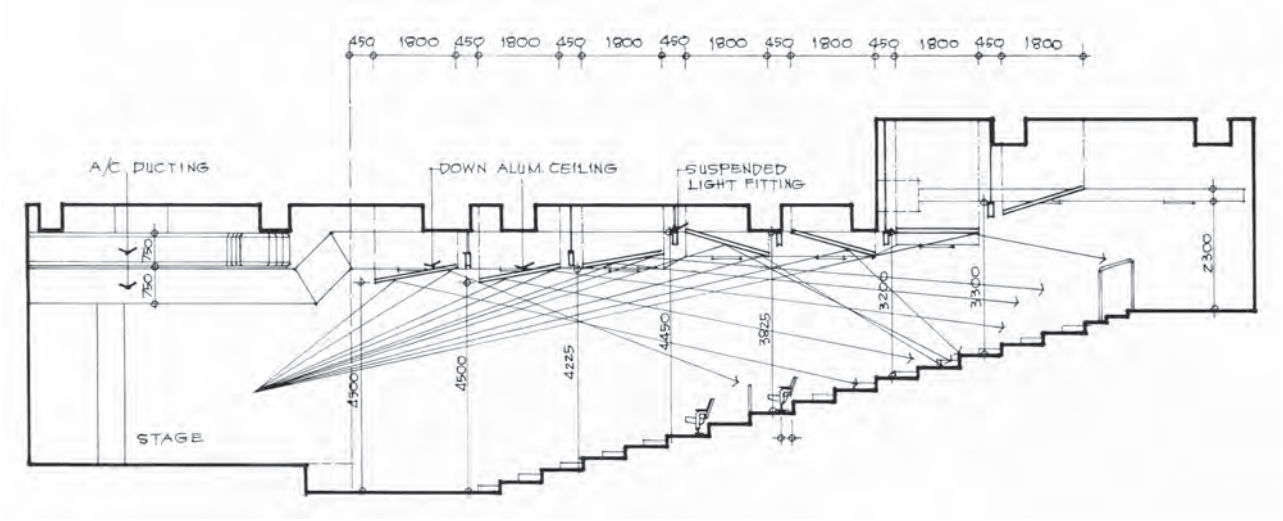
The project was completed in 1983. Later, in 1991, a four-storey block of 16 classrooms was constructed as an addition to the school, with similar architectural details.

在山坡上的一個小地段，依循政府條例對學校設計的高度限制，同時要從設計中反映法國的教育特徵，確實是項不容易的建築工程。

建築師利用中庭作為建築物的重心。繞著中庭為幾座不同功用的建築物，如小學部份、中學部份、行政大樓和康樂大樓等。平面的圖形看來，有點像風車的模樣，是一個充滿動感的構思。

因為地段的斜坡問題，所以在設計上，建築師巧妙地把不同用處的建築物，配合不同的設計水平面高度，以露天的走廊把它們互相連接起來。如此的設計安排，消除了斜坡對於建築的限制。而且在建築物的每一個角落，都可享受到周圍的景緻。

Entrance of the school



Visual angle is considered at the auditorium

Architectural details

The rugged texture of conventional fair-faced hollow concrete blocks forming partition walls for the classrooms are expressed as a new life on the corridor. However, the concrete blocks inside the classroom are plastered and emulsion painted to give a more neutral texture for the classroom.

Drainpipes were designed with the columns to form an architectural element that expresses truth of construction and services. Inverted dome-shaped MacLeod aluminium planters were added along the corridor to add colour and life to the school environment.

Facing the outside wall of the classroom, fan coil units were installed; 200 mm diameter air louvres were installed and expressed on the external wall as a uniform pattern. The auditorium is designed with an acoustical reflective ceiling together with acoustic absorbing panels in the end wall. The latter is treated with fire-resistant paint every year, because the auditorium has to satisfy the local fire code as a place of public entertainment.

Skylights were built on a 1,300 mm grid of reinforced concrete frame for walkways and pergolas. Acrylic domes incorporating surface drains were installed.

Graphically, reds, blues, and whites are used to symbolize French dominance.

建築的設計特點

以未經打磨的傳統空心磚作為課室的間牆，使外面的走廊通道有著一種難以形容的生氣。但課室內，牆身都是經過粉飾後再加灰水英泥，整齊而雅觀，配合課室內的學習氣氛。

此外，倒置的鋁質模製圓拱型花盆圍繞中庭的走廊，亦扮演了很重要的角色，為校園的學習環境添上一份色彩。

建築設計時所忽略的一般建築設備，如雨水喉、空調安置等，在這裏都經過細心研究，成為建築的細部，同時達到外觀與實際的功用。譬如垂直的雨水管收藏於柱的暗角內；而空調用的通風百葉，在外牆上排列出一個統一的形態，使單調的外牆變得有韻律。

禮堂是一般學校必需的空間之一。這裏的禮堂設計更是特別，除了安裝有音響用的天花外，還在周圍加上吸音板來控制音響的強弱回聲。根據香港的防火條例，這些吸音板是需要每年都塗上一層防火油的。

天台休憩的地方，興建了一條有蓋的行人廊，當中的設計還得考慮如何擺放雨水喉管和透明的半圓天花。

在平面設計上，建築師還利用紅、白、藍三色去表現法國色彩。

Client:	French International School Association, French Consulate
Architect:	Patrick Lau of Design Consultants
Structural and Geotechnical Engineers:	P. S. Chung & Associates
Building Services:	Mao & Partners
Interior Design:	Ruby Lau
Landscaping:	C. K. Wong
Quantity Surveyor:	Eric Cheng
Acoustics:	Stephen Lau
Theatre Lighting:	Ian Campbell
Theatre Sound:	Jacek Figwer
Completion:	1983–91 (additional Phase)



External and internal walls of classroom and concrete block details

3.16

Sam Tung Uk Museum: Landscaping and External Works

三棟屋博物館：園林設計

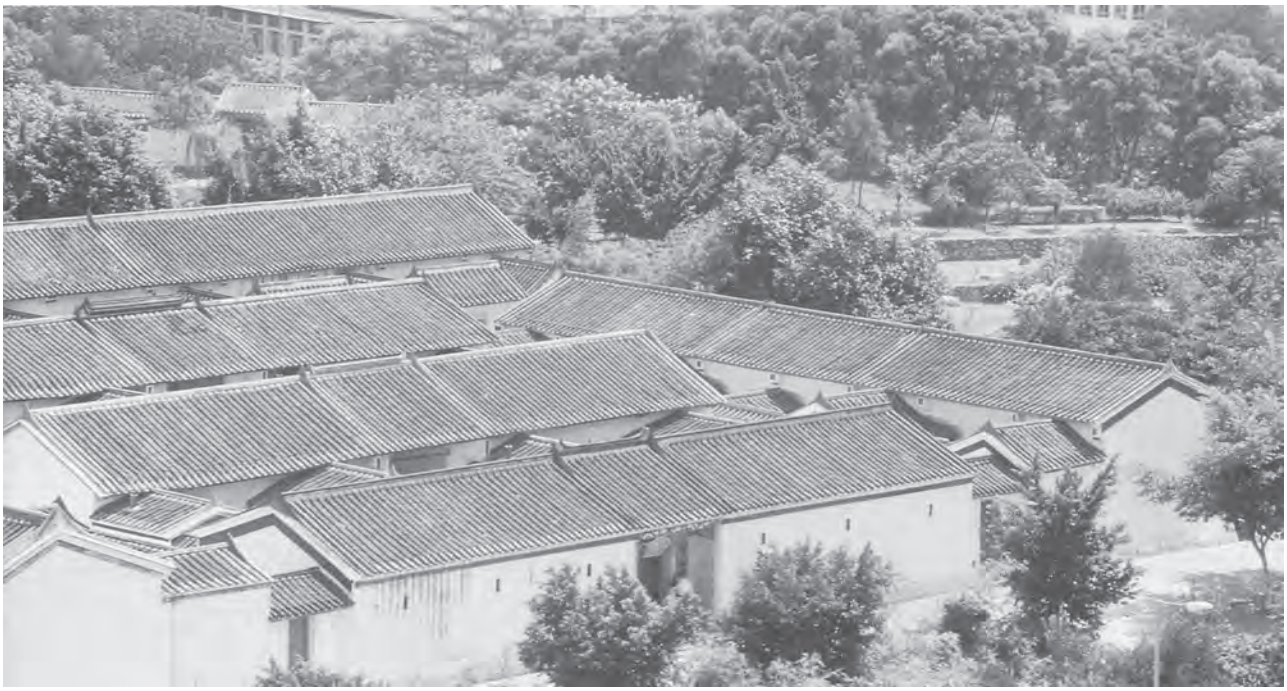


Photo showing the cluster of rooftops at Sam Tung Uk

Built about 200 years ago by the Chan family, and now turned into a folk museum, Sam Tung Uk, as the name means, contains three rows of houses, the fourth added at the rear and at a later stage. This is a good example of a single-clan walled village.

今日的三棟屋博物館，前身原是二百年前一位陳姓的祖屋。原址建築群為三行並排而列的房舍，乃取其設計的組合，故以「三棟屋」命名。現經政府重新修建，在三棟之外還多建第四棟並排的房舍。三棟屋可說是傳統圍村式的民居建築。

Landscaping concept

A natural and somewhat primitive setting was the concept for this 6,000 m^2 garden. Terraces simulating the cultivation of fields in the countryside slopes were used as the main landscaping element and as a backdrop to the museum. Folk culture is experienced in the museum as well as in the surrounding landscape. Even the pond was designed with a rustic appearance on the edges. This is the case when irregularities and non-alignment are arranged with subtle details to form controlled vistas. The line of vision along the meandering paths is an important aspect of the design.

園林設計的概念

博物館坐落的地方，有著一個偌大的後花園，而這 6,000 平方米的後園設計，充滿著自然和諧的格調。高低起伏的台階，穿插著細意安排的綠草和花卉，有如傳統鄉間所見的梯田樹苗，更顯出博物館建築物的特色。一般中國園林的意境，諸如亭台流水，迂迴曲折的小徑，在此處自是盡見一斑。

Precast concrete pavers

The artificial terraces in a farm-like setting

Landscape details

To form the terraces, a 300 mm wide stone wall about 500 mm high was built as a toe wall. Subsoil drains with stone surround were installed to avoid flooding. A reinforced concrete footing was constructed as the base.

The precast concrete slabs finished with exposed aggregate for paving are designed to form either a regular hexagonal pattern or a random pattern. The slabs were then set in 75 mm thick, 50% sand 50% soil mix and on top of a 100 mm thick hard core.

Granite boulders are natural building material compatible with the landscape. Some are naturally finished and set to hide and contrast with artificial signboards and parapets. Others are cut flat and used as tables and seats. The placing of these boulders is usually done onsite rather than on the drawing board.

Bentonite lining of 200 mm thick forms the base of the pond. This was selected for its workability over irregular surfaces. A boulder layer of 200 mm thick forms the finishing base. An artificial stream of a 200 mm reinforced concrete base and waterproof cement sand rendering leads water into the pond. Boulders were added along the stream for a natural look.

園林組織的細部

起伏的台階以 300 毫米闊及 500 毫米高的石牆組成。為了防止積水，大石堆的周圍設有地下疏水管，而底層則為結構混凝土。

預製的混凝土層面之上以粒料構成六角形或不規則的圖案，最後用 75 毫米粗的混合料（沙和石各佔半份）附在 100 毫米厚的硬層之上。

園中的天然麻石，形態和大小各異，都是依據設計者的構思，放置在現場環境的擺設，除了作為造境之用，更是遮蔽或對比園內的牌碑和公用設施。

環繞荷花池的旁邊為 200 毫米厚的皂土，其特性可隨著水池的邊圍，作不規則的線條組合。而在水池的另一邊為一人工的小流川，以防水泥沙在 200 毫米厚的混凝土層之上建成。周圍還放置不同形態的天然石堆群以作點綴。

The pathway and the pond

Gatehouse

The gatehouse represents a modern way to have a traditional Chinese building. The roof is constructed of 100 mm thick structural concrete slabs. An asphalt waterproofing layer was applied before the Chinese clay roof tiles were laid with mortar and wire mesh reinforcement. Underneath the concrete slab is another layer of clay tiles supported by wooden battens and 150 mm diameter timber purlins which are fixed with ends onto the concrete wall.

Natural granite architrave and a threshold with hinge block and granite socket block were used to fix the wooden door, which is also constructed in traditional style with a wooden latch lock.

Flooring is 30 mm exposed aggregate concrete paving on reinforced concrete slab set on waterproof membrane, blinding layer, hard core, and compacted subgrade.

The gatehouse

The final product of the gatehouse with its storeroom and kiosk harmonizes with the surrounding landscaping and merges with the original Sam Tung Uk Museum. Much of the success is due to the concern with details and correct use of building materials and techniques.

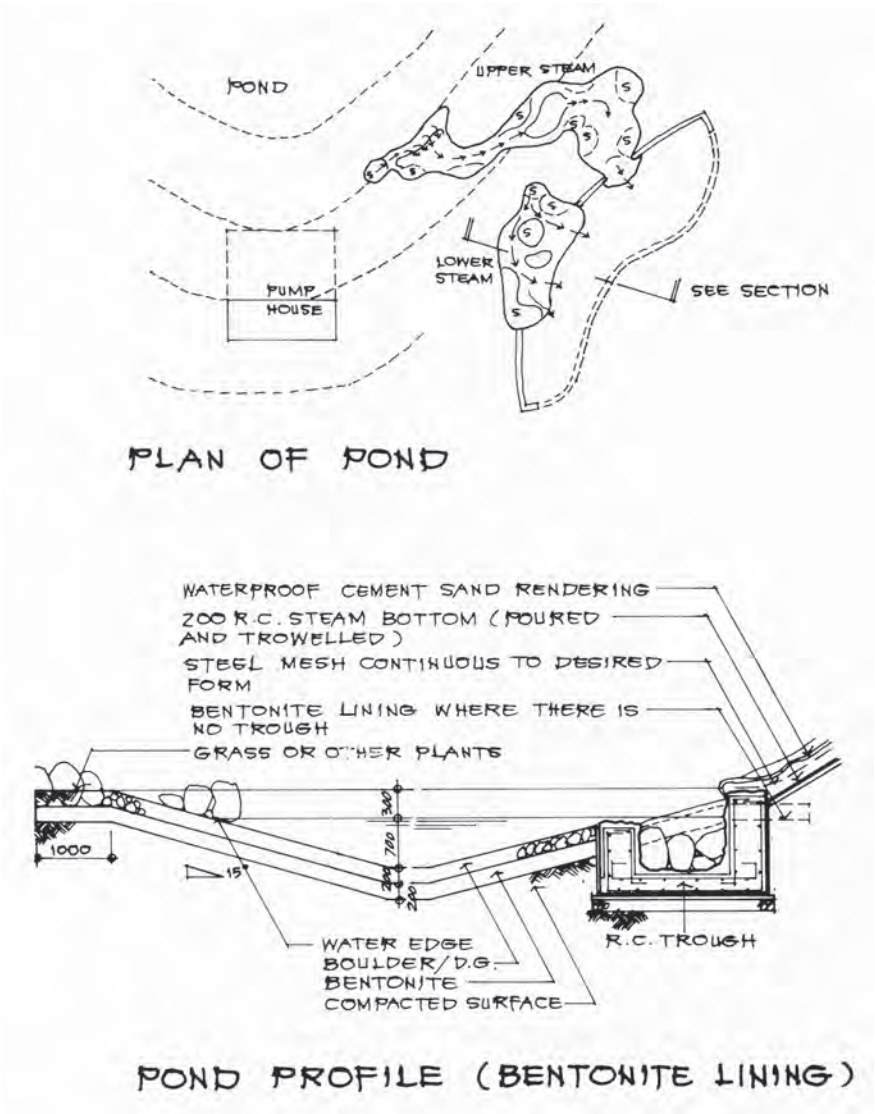
門房

門房在傳統的中國建築中，有著特別的意義。新建的門房以新的建築模式把它的象徵重現在這博物館中。

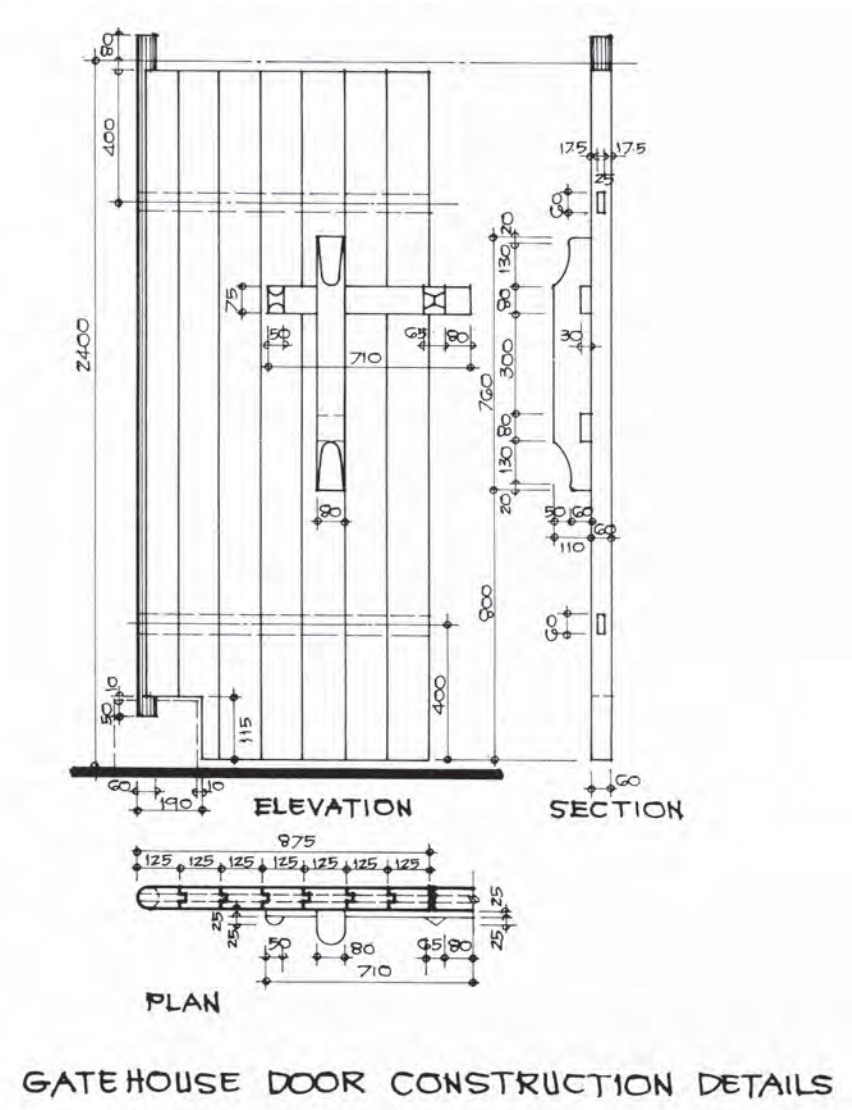
屋頂變為 100 毫米厚的結構混凝土，在防水瀝青層之上才鋪放中國式的天面黏土瓦。屋頂的底部亦鋪放同一的黏土瓦，另更仿效古法用木結構而加上木條和 150 毫米直徑的桁條。

天然麻石作為門頭和門腳，配合木構成的門栓，都是仿照傳統中國的木門樣子而設計的。

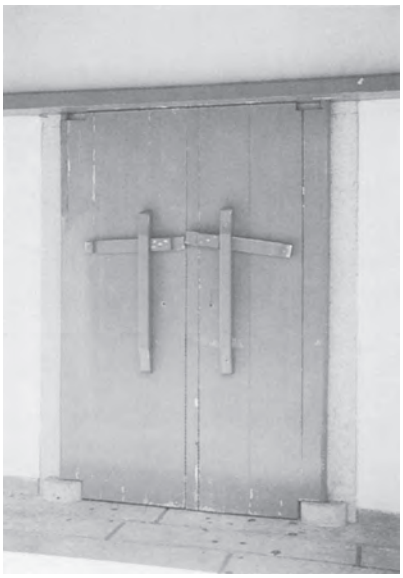
地面亦由粒料構成不規則的圖案，使鄉村味道更濃。仿古細部設計，使新的門房為博物館增添幾份懷舊氣氛。



Plan of the pond and its profile



Gatehouse door construction details



Wooden door of traditional construction

Client:	Tsuen Wan New Town Development Office, New Territories Development Department
Architect:	Patrick S. S. Lau of Design Consultants
Landscape Architect:	C. K. Wong
Contractor:	Yan Lee Construction Co. Ltd.
Year of Completion:	1988

Chapter 4

Drawing Practices: From Design Sketches to Tender Drawings

從草圖到招標圖

Kee Yee Chun, Tris 祁宜臻

> I prefer drawing to talking. Drawing is faster, and leaves less room for lies.
>
> — Le Corbusier

Drawings are the fundamental tools for architects to communicate. This communication exists on multiple hierarchical levels, ranging from that between architects and clients, architects and contractors, to contractors and suppliers. At the very gestation stage of a design concept, the sketch is often the architect's first tool to explore different ideas. This earliest stage of concept formation is bounced back and forth, traced and retraced on the sketch papers—a fundamental way to communicate between the eye and the mind. When the architect begins to move from the initial conceptual stage to subsequent stages of built work, these drawings take on a completely different set of tones and voices. For instance, at the conception stage, drawings tend to be less technical and more poetic and impressionistic. The objective of these first drawings is to provide the client the opportunity to endorse a design direction from a decidedly emotional level.

> Drawings are the expressions of one's striving to reach the spirit of architecture.
>
> — Louis Kahn, 'Space and the Inspirations' (1967)

> 比起交談，我更喜歡繪畫。繪畫省時，且不會謊言連篇。
>
> —— 勒 • 柯比意 (Le Corbusier)

對建築師而言，繪畫是最基本的交流方式。建築師、客戶、供應商之間的溝通就是以圖像作交流的。建築師們在醞釀概念初期，亦常會將不同的想法速寫於草稿紙上。於是，畫紙上便會重複出現各個想法的雛形、概念演變以及再生的痕跡，這是逾越感官的一種基本交流方式。當建築師完成初期的概念創作，進而開始更深入設計時，這些繪圖所發揮的功能與作用，則大不一樣。舉個例子，概念初稿僅注重整體架構，構圖方面相對而言較抽象，欠缺細節的描繪。初期的繪圖旨在為客戶呈現設計概念的基本雛形，讓客戶釐定設計方向，因此，概念形成時期的繪圖相對而言較簡潔。

> 建築師均以繪圖及設計致力達到建築的精神。
>
> —— 路易斯 • 康 (Louis Kahn), 'Space and the Inspirations' (1967)

The Evolution of Drawing Practices

Today, the tradition of drawing on yellow sketch paper and tracing and retracing the master's work to develop a project has given way to contemporary digital design. Computer-aided tools have changed the culture and comprehension of architects' drawings in an unprecedented way. Three-dimensional modelling can be coupled with fabrication methods, so even tentative thoughts may appear to be rendered 'final'. These first drawings are meant to provide the client a means of cultivating the architect's ideas and spatial concepts. The craft and intelligence of executing new work is apparent in all drawing methods, whether generated by tedious hand tracing on vellum with technical ink pens and T-squares, or through the quick click of a computer mouse.

This chapter opens with discourse of the evolution and development of drawing practices. Through examples ranging from the old—construction

drawings on vellum, personal sketchbook narratives, and abstract ink or charcoal paintings—to the new, including sophisticated parametric-formulated geometries, the array of works shown here not only reflect how architectural works are conceived and perceived but showcase their diversity and beauty which transcend mere function to become art.

Though it is inevitable that the old modes of drawing have been more or less replaced, there remain a few practitioners who are reluctant to surrender their T-squares and triangles. Some find themselves nostalgic for the meditative intellectual spaces that open up as they trace lines on paper. Like a sculptor working on a piece of wood or a musician stringing an instrument, an architect can yield to the joy of developing thoughts through the act of drawing and find emotional peace in its slow emergence.

An architect's repetitive tracing and retracing of lines amounts to more than a mere transfer of information but is in and of itself a meditative indulgence into the plan, a kinaesthetic reviewing of information. The pen in the hands of an architect is not qualitatively different from wood in the hands of a sculptor or an instrument in the hand of a musician. The drawing takes repetition to perfection; hence, architects love to trace and retrace their sketches to perfect the scheme and channel the vision from mind to hand.

In his recent book *Why Architects Still Draw* (2014), Paolo Belardi, an architect and professor in the Department of Civil and Environmental Engineering at the University of Perugia, wrote 'drawing by hand is an active way of thinking'. In our era where drawing software and AutoCAD are widely available and 3D-scanners and GPS devices are so close at hand, the question is: why do architects still draw by hand? Here, Belardi offers an elegant and ardent case for the value of the organic relationship that drawing creates between the mind and the hand without shunning new digital media for design.

Belardi suggested that drawing is the holistic manifestation of a particular design. 'It is the paradox of the acorn: a project emerges from a drawing—even from a sketch, rough and inchoate—just as an oak tree emerges from an acorn. Citing examples not just from architecture but also from literature, chemistry, music, archaeology, and art' (Belardi 2014).

Belardi further argues that 'drawing is not a passive recording but a moment of invention pregnant with creative possibilities'. Over the centuries, architects' drawings have evolved in style and philosophy, from Piranesi's eclectic etchings (1720–1778), to the modernist approach of training architects to develop ideas through the very act of drawing. This approach, while 'modern', was actually developed as early as 1937 by Walter Gropius, who initiated the then new notion of using drawing as a focus to train architects in the pedagogical program for his modern paradigm of architectural education.

This chapter consciously chooses not to dive into the discourse that drawing is the underpinning principle of architectural education but rather the simplest way to digest discussion on the approach of setting out to draw from a simple sketch on vellum to a full set of production drawings.

Those who appreciate Kahn's preference for sketching on vellum and his devotion to repetition watch raptly as his squares shift, turn, and interact in countless forms of spatially orientated variation. In the chapter 'Drawn on Yellow Paper: Toward a Culture of Lingering' (Merrill 2010), Kahn explains his preference for the thinnest of yellow paper: 'this is like a painter's flag, for work in progress, that however detailed and elaborate that which is drawn upon it may be in fact, still "wet", in flux, subject to change, criticism, rejection.'

This chapter will not be a full survey, nor will it indulge in the history and culture of architectural design and drawings; rather, it offers an overview of the development of a set of 'informed drawings' as well as things to consider when a beginner assumes the task of drawing. The discourse opens with the introduction of the various types of drawing and their trajectory, from the preparation of tender drawings, to detail drawings, and finally a set of construction drawings. The complete set of tender and construction drawings may convey similar information; however, depending on whether the drawings are intended for communication to potential tenderers or to the worker on site, they will cater to each accordingly. We would like to thank the architects who have contributed their drawings and images to this chapter as illustrations.

繪圖的進化史

將概念繪於黃色素描紙上不斷進行修改、潤飾的傳統設計方式，已不復存在，取而代之的是當今新興的各類電腦設計軟件。這些新興的電腦設計工具以前所未有的方式，改變了建築師們對於繪圖的理解及實踐。三維立體模型配以加工法，能夠將臨時性的設計想法表達得相當精細，所呈現的設計圖已似最後成品。然而，即使新舊設計方式所採用的平台及工具有所不同，兩者都能培養建築師的概念及空間感。不論是用專業墨水筆和丁字尺，不厭其煩地在牛皮紙上慢慢勾勒，還是簡便快捷地輕按電腦滑鼠，都能夠將創作一份新作品的工藝及智慧，詮釋得淋漓盡致。

本章會介紹大量的案例，以講解繪圖的進化史，從舊式畫在牛皮紙、素描簿上，以及用水墨或炭筆作抽象畫，到新式基於標準參數以繪製幾何圖形。案例中所涉及到的一系列作品，不僅為大家講解了建築的構思及感知，且詮釋了建築作品的多樣性及美感，令建築昇華為藝術品。

儘管舊的繪圖模式無可避免會被取代，但仍然有少數從業者不願意擯棄丁字尺和三角板。在紙上繪圖能夠勾起懷舊的思緒，沉醉於設計的空間中，好像一位雕塑家努力雕琢一塊木頭，或是一位音樂家細心彈奏一件樂器。通過繪圖這個動作，一名建築師總能夠在構思概念的過程中找到樂趣，並在概念漸現的過程中，找到內心的滿足感。保羅 • 比拉迪（Paolo Belardi）是佩魯賈大學土木與環境工程系的教授，同時作為一名建築師的他於新書《為什麼建築師們仍然作畫》（2014）中這樣寫道：「手工繪圖是一種積極的思考方式。在當今繪圖軟件廣泛應用、三維掃描儀以及全球衛星定位裝置唾手可得的年代，我們該問的是為何建築師們仍然會選擇手工繪圖？」比拉迪認為繪圖是一種直接的方式，讓大腦向雙手傳達訊息，而不用迂迴地透過電子媒介表達設計意念。

比拉迪認為圖則可以表達設計的整體性。「這種設計的過程就像橡果悖論一樣有違常理：一個項目始於一張圖，甚至有可能是一幅粗糙的原始畫作，就好比一棵橡樹始於一顆小小的橡果。」（Belardi, 2014）所引述的例子不僅僅涵蓋了建築學，且包含文學、化學、音樂、考古學以及美術。

比拉迪進一步論證繪圖不是被動地將想法記錄下來，而是一種「創意的厚積薄發」。在過去的幾個世紀裏，我們見證著建築師們創造出一系列非凡的作品，從最早期皮拉內西（Piranesi）不拘一格的蝕刻版畫，到以現代主義形式訓練建築師的繪圖技術及思考方式。沃爾特 • 格羅佩

斯（Walter Gropius）亦於 1937 年提出新的訓練建築師的方法，將繪圖作為現代建築學教育中的重點內容。

本章不會將重心放在「掌握繪圖技藝為建築教育的基本原則」這一話題上，而將著重探討由牛皮紙上的簡單素描，到最終完成的設計圖所採用的方法。

路易斯 • 康堅持在牛皮紙上重複地素描，在每個繪畫的角落變化著、互動著，以無數的組合嘗試不同的建築空間。在〈繪於黃紙上：走向勾留的文化〉一章中，路易斯 • 康這樣解釋他對最薄的黃紙的偏好：「未完工的作品，就好比是畫家的一面旗，不管該作品事實上已有多麼精細靈巧，它仍未『晾乾』，仍可改動，並隨時受制於外來的需求、批評甚至乎拋棄。」

一名建築師於畫紙上所勾勒出的原始線條，以及後期多次加工的痕跡，不僅僅傳遞著一種簡單的訊息，其創作本身便是一種認知的過程，一種對設計的深度反思。建築師手中的筆，從本質上相當於雕塑家手中的木頭，抑或是音樂家手中的樂器。熟能生巧，於是建築師鍾情於不斷修改和加工手中的繪圖，直至其完美。

本章的重點既非對建築繪圖史進行一場深入探索，亦非追溯其歷史與文化，而是提供針對一系列知情繪圖的概述，以及相關的初學者需知。

本章開篇會介紹不同類型的繪圖以及它們的製作方式，包括最初的招標圖則，到細節圖及最後的施工圖。一套完整的初期招標圖，則與最後的施工圖有可能非常相似，取決於圖則是否用於招標或施工參考。作者必須感謝為這章提供圖則和照片作插圖的建築師。

Tender Drawings and Contract Documents

Built environments are often complex, involving many designers, planners, consultants, and contractors in different fields and multiple stages of operation. The documents defining the contract are also complex and need to be comprehensive to accommodate the diversified backgrounds of each specialist. The task of preparing them for tendering therefore requires close attention to detail and a uniformity of approach, so as to achieve a coherent set of documents, forming an unambiguous and manageable contract. Aside from a series of drawings, a typical set of documents needed for tendering include the following:

- general conditions
- site preliminaries
- instructions to tenderers
- general and particular conditions of contract
- specification
- bill of quantities
- tender and appendices

For the built industry, the tender is a formal invitation to suppliers to make an offer to the buyer for the supply of goods and services as set out in the specification document within the formal tender document. In architecture, a contract is the formal agreement between the client and the contractor; it states the various services and deliverables expected of the contractor within the requested timeline and the expected contract price.

Contracts form an important part of the materials needed in calling tenderers to submit for a construction project. In the built/construction industry, the contract is a legally binding agreement between two parties with respect to the obligations of each party to the other and the liabilities.

There are several components to the formation of a complete contract.

招標圖及合同文件

建築環境是一個相當複雜的概念，因其涉及多個階段、多個行業的不同設計師、規劃師、顧問及承包商。正因所涉及的行業眾多，合同文件的條文則變得相當複雜，所涵蓋的內容亦因此必須相當全面。為準備該合同，創建者與相關協助者需十分注重細節以及方案的統一性，方能成功完成一份合理、清晰、可行的合同。除了一系列的繪圖，一套典型的招標文件還需包括下列內容：

- 一般條款
- 地盤的基本資料
- 投標指引
- 一般以及特別合同條款
- 規格/詳細說明
- 工料清單
- 標書與附錄

對於建築業界來說，投標是一份正式邀請函，邀請各供應商為某商品或者服務競價，具體競價商品或服務，則記錄於正式投標文件中的規格/詳細說明中。對建築界來說，合同指的是客戶與承包商在指定時間內提供指定價格的服務。

合同在一個工程項目招標的整個過程中，扮演著一個非常重要的角色。建築業的合同為雙方針對責任與義務所制定的合法並具有約束力的協議。

一份完整的合同需包括以下部份。

Instructions to tenderers

Instructions to tenderers inform the contractor where and when to deliver the tender as well as information regarding guarantees, bonds, and issuance. They may also contain information regarding items that will be supplied by the employer and sources of materials to be used in the contract, as well as proposed methods for construction.

投標指引

投標指引詳細說明了承包商該於何時何地投標以及所需相關保證書、債券、保險等信息。指引中亦有可能同時包括僱主所提供的特定條件、所採用的具體材料以及預計的施工方案。

General and particular conditions of contract

The general conditions of the contract may include any of the forms of contract. These may be amendments or additions that the employer wishes to make to the standard conditions. Standard conditions are not usually reproduced in the tender documents but will be named by specific reference, and a schedule will show the changes that have been made to them.

一般以及特別合同條款

一般條款可能包含任何一種「標準」形式的合同。而特別合同條款則由基於一般條款之上的修訂或附加條文組成。通常標準條款將不會在投標文件中再次被提及，只會以特定參考命名，且附有一份進度表列明上述條款的改動痕跡。

Specification

The specification focuses on quantitative information. It explicitly states the quality of materials and workmanship utilized, methods of installation, and finally, details regarding any laboratory testing to be used to comply with regulatory approval. The specification usually starts with a description of the works to be constructed, followed by all relevant data concerning the site, places of origin, size, the bonding method, and finishes. (Details are in Chapter 5.)

規格/詳細說明

規格/詳細說明中所涉及的主要是定量的資料。當中列明了材料的質量、所用工藝、安裝方法以及符合法例要求的各項詳細資料。規格/詳細說明通常先以工程介紹作開始，然後再逐一指定各種詳細要求，包括：工地基本資料、起源地、尺寸、結合方法、成品（其他詳細內容在第五章詳述）。

Bill of quantities or schedule of rates

The bill of quantities or schedule of prices is often interpreted as similar, but in fact the two are quite distinct. The Bill of Quantities (known as BQ) is frequently prepared by quantity surveyors. It is prepared for the costing of a building, and data are estimated from measurements provided by architects, structural engineers, and other building consultants. The costing information in a BQ contains estimates on various surface areas of the building in meters, including walls, floor areas, and roofs. It also contains a formal count on the number of doors, windows, and building service systems such as heating, cooling, plumbing, and electronics. It should be noted that the costs of labour and materials fluctuate constantly in the contracted period.

Historically, the practice of estimating building costs in BQ format arose from non-contractual measurements; the tenderers used drawings to assist in quoting lump-sum prices. A BQ shows the number or quantity of each item and its unit of measure, the rate per unit of quantity as quoted by the tenderer, and the consequent total price for that item. Bills may be quite complicated and contain hundreds of items, classified by trade or by a standard method of measurement. Other bills contain far fewer items.

Whereas the BQ provides an itemized list that includes the works to be constructed against each item of which the tenderer must quote a price, a schedule of prices may, by contrast, be much less specific. It may list provisional quantities, which are estimated. The schedule of prices is useful in many cases, including times when quantities (number of items, dimensions, or total areas) are fluctuating or uncertain.

工料清單及估價表

通常在合同中，一份工料清單可理解為一份估價表，但實際上兩者大不一樣。工料清單通常由工料測量師所制定。工料清單估算的是一棟建築的價格，這價格是基於建築師、結構工程師以及其他顧問的繪圖而估算出來的，其中包括牆壁面積、地面面積、屋頂面積、門窗的數目、冷暖氣供應設備、管道系統以及電器設備。不過，制定工料清單時要留意勞工成本與材料價格在合同期間的波動。

以往基於工料清單對建築成本的估算均為非合同類措施，投標者以建築繪圖作參考制定估算價格。一份工料清單中列明了每一個項目的數量及計算單位、每單位競標價格以及該項目的總價。工料清單有可能極其複雜，其中包括上百件項目，按交易分類或依照標準測量分類。而其他類型的清單相對而言較簡單。

估價表相對而言比工料清單簡單。承包商必須在工料清單中詳細列明每一個項目的工序及相應的工料及價格，但估價表只需列出估算的工料數量。因此在工程需求（項目所需的數量、尺寸及總面積）會變動或不明確時，估價表便會大派用場。

Tender and appendices

The tender is the tenderer's formal offer to undertake the contract; it is where the tenderer enters his or her sum price. The appendices to the tender contain other matters defining the contract's terms from which the tenderer will confirm acceptance of the offer. These terms may include a specific time for completion of the work, details of the consequences for failure to complete on time, the minimum amount of insurance, and the completion of bonds. Other specifics may include sources of materials and currency exchange rates (for international contracts).

標書與附錄

投標即投標人正式接受合同，在標書中清楚列明投標人所投總額。而交予投標人的附錄，則包含了合同條款的定義，投標人同時亦會參考該條款以確定是否接受招標邀請。條款可包括工程完工的具體時間、未於指定時間內完工的後果、保險金額的最小數目等等。此外，標書亦有可能列明其他相關的條文，例如貨幣兑換率（適用於國際性合同）或材料的來源。

Chapter 5

The Importance of Construction Specifications

施工規格的重要性

Wai Chui Chi, Rosman 衞翠芷

The Role of Specifications

Construction specifications are important documents that communicate the design intent of the architects and the engineers to the contractors. They are written descriptions of the project and are used to govern the quality performance of its construction works. The specifications, together with the agreement, conditions of contract, drawings, and the bills of quantities (BQs) in traditional design-tender-build projects, are major components of tender documents for bidding on the construction of projects. These documents will subsequently become contract documents for construction work after signing the agreement, which is the contractual agreement between client and contractor that the former will pay the contract sum when the latter performs the construction work as specified.

During the construction stage, specifications are essential documents for contract administration. The specifications spell out clearly the acceptance standards of the architect or the engineer on materials, workmanship, and other obligations under the contract. They are also important documents in determining any variations from the contract, measuring interim payments and imposing penalties for substandard work. In the final account stage, specifications provide a strong reference in ascertaining variation costs and claims, as well as settling disputes in contracts.

While drawings are graphic descriptions of the work to be performed by the contractor, specifications are the text description of it, and the BQs detail the quantities and cost. These documents complement each other and are essential for the complete understanding of the work. Whenever there are discrepancies among these documents, the contractor should seek clarification from the architect or engineer, who will clarify his or her intention through the instructions of the architect or engineer.

施工規格的作用

施工規格是建築師和工程師用來傳達設計意圖予承建商的重要文件。它們是項目的文字描述，用以管理建築工程的質量。在傳統的設計－招標－建造項目的招標文件中，施工規格，連同協議、合同條件、建築圖紙和工程量清單，是投標文件的主要組成部份。而這些文件在業主與工程承建商簽署協議後，將成為合同文件。簽署協議，代表著業主承諾當承建商完成執行規定的建設工程後將支付合同款項。

在施工階段，施工規格是合同規管的必要文件。該規格註明了建築師或工程師對材料、工藝和一般須遵守規範的明確驗收標準。它們也是用來決定何為合同中的改動，和計算中期付款，以及當工程質量低於合同標準時，計算罰款款額的重要文件。在決算階段，施工規格更為確定合同中的變動成本及索賠，以及在解決合同爭端中，提供重要的參考。

圖紙是用圖像，而施工規格卻利用文字，向承建商描述合同裏的工程，至於工程量清單則詳盡地列出工程內有關材料與工藝所需要的數量和成本。這些文件對理解整個工程內容是相輔相成、缺一不可的。每當這些文件之間的資料有差異時，承建商須向建築師或工程師查明，讓他們透過建築師指示或工程師指示澄清設計的本意。

Format of Specifications

Most common construction specifications used in Hong Kong are of the prescriptive type. Some may use the performance type of specifications, or a combination of both prescriptive-based and performance-based specifications. In the prescriptive specifications, all requirements of the work in materials, workmanship, and other obligations are specified in every detail. In the performance specifications, only the functional performance requirement of the completed work is specified, so the contractor is free to develop his or her own method to achieve the result. Prescriptive specifications give the architect or engineer more certainty of the final outcome of the construction and make process-control during the construction possible, but his or her knowledge of the construction activities is required when drafting the specifications. Performance specifications are more suitable for construction works that require the contractor's input in a portion of the design work, which is associated with construction technique, or works that call for the contractor's innovation in construction approach.

Different construction specifications are used for different contract types, including site investigation, site formation, foundation, superstructure, nominated subcontracts, etc. The specifications usually contain two parts: one is the general specifications, which are standard requirements and conditions of construction. They are usually used for all similar contracts in the same architectural or engineering firm. The other part is the particular specifications, which are specifications clauses particular to the contract works, and can take precedence over the general specifications.

施工規格的格式

在香港，最常使用的施工規格是規範類的。有些會使用工作性能類的規格，或集合規範類和工作性能類為基礎的規格。在規範類的規格中，材料、工藝和一般須遵守規範裏的所有要求，均詳細列明。然而，在工作性能類的規格裏，只須指明工程在完成時的工作性能要求，承建商可以自由地選擇自己的方法來完成工程。規範類的規格讓建築師或工程師更能掌握工程落成時的效果，並能控制施工過程，但它要求建築師或工程師對各項建築活動有所認識，才能起草施工規格。而工作性能類的規格，比較適合一些需要承建商投入與他們施工工藝相關的設計工作的項目，或一些要求承建商在施工技術方面有所創新的工程。

不同的合同類型會使用不同的施工規格，包括現場勘察、地盤平整、基礎、上層建築、指定分包合同等。施工規格通常包含兩個部份：第一部份是一般規格，這是一般標準的要求和建築條件。它們通常適用於同一建築或工程公司所有類似的合同。另一部份是特殊規格，這是特別為該工程合同訂定的規格條款。而特殊規格的要求是可以凌駕於一般規格的要求的。

Organization of Specifications

Most of the specifications are arranged in sections by construction trade in the chronology of the works, but some specifications may be arranged by the building components, for example, windows and doors, in which all trades of the same components grouped together. Specifications arranged by trade is more

convenient for subcontractors of each trade to find their own work scope in the specifications. Arrangement by components has the merit of grouping all necessary trades in building the components, thus making it an easier reference for the manufacturers and subcontractors of the building components.

For specifications arranged by trade, both the general specifications and particular specifications are arranged according to the working sequence of building works on site. Take specifications for building works as an example. The typical arrangement of the various sections is as follows:

1. demolition
2. earthwork
3. concrete
4. masonry
5. structural steel
6. roofing
7. carpentry and joinery
8. ironmongery
9. curtain walls
10. metal works
11. finishes
12. sanitary appliances
13. glazing
14. painting
15. internal fittings and fixture
16. plumbing and drainage
17. landscape works

For complex projects, separate contracts are used for site formation, demolition, foundation works, interior decoration, and so on. Like the building contracts, the requirements for materials, workmanship, and other obligations of these contractors for the individual works are spelt out clearly in the specifications of these contracts. Similarly, the nominated subcontracts of the building service works, such as air-conditioning installation, fire services installation, water services installation, and electrical installation, will have their own specifications in each nominated subcontract.

施工規格的結構

大部份的施工規格，都是根據各建築行業在工程進度中出現的時序來編寫的。但有一些施工規格，則是使用建築構件來分類的，例如窗戶、門等，把所有製造該建築構件裏的各建築行業組合在一起來編寫。根據建築行業編寫的施工規格，有利於每一個行業的分包商，讓他們在施工規格裏更方便地找到自己的工作範圍；而使用建築構件來分類的施工規格，則方便那些建築構件製造商和分包商。

以建築行業為本編寫的施工規格，無論是一般施工規格或特殊施工規格，都會根據建築工程在現場工作的時序來編寫。以建築工程的施工規格為例，各部份的標準安排如下：

1. 拆卸
2. 土方
3. 混凝土
4. 石工

5. 結構鋼鐵
6. 屋頂
7. 木工和細木工
8. 小五金
9. 幕牆
10. 金屬
11. 塗飾
12. 潔具
13. 玻璃
14. 油漆
15. 內部配件及固定裝置
16. 給排水
17. 園景工程

對於複雜的工程項目，通常會把地盤平整、拆卸、基礎工程及室內裝修等工程，分開使用個別獨立的合同。但一如建築工程合同，這些合同也必須註明對材料、工藝和一般須遵守規範的要求。同樣，對於屋宇裝備的指定分包合同，如空調安裝、消防安裝、供水服務安裝、電器安裝等，也需要在每個指定分包合同中，列出個別的施工規格要求。

Preliminaries

In the common arrangement of the specifications, there is a section on preliminaries preceding the works sections mentioned above. The preliminaries give an introduction to the specifications, explaining the applicability in the contract and the meaning of the terms used. The main part of preliminaries is on the general obligations of the contractor, detailing his or her obligation in (1) taking care of the works and the site; (2) maintaining existing services, features, and trees; (3) maintaining the safety of the workers and the work on site; (4) avoiding any environmental nuisance to the surroundings; and (5) spelling out any special requirements on site personnel, contractor's submissions, materials, and workmanship in general. The preliminaries also specify requirements on any temporary works and services on site, including those of the access roads, site offices, hoardings, and scaffoldings. They also specify the contractor's obligation in providing attendance to all the nominated subcontractors, specialist contractors, government departments and utilities undertakings on site for completion of the work.

初步總覽

在常見的施工規格中，通常會在上述有關建築行業規格的前一章，編寫初步總覽，介紹該施工規格及其適用範圍，以及各名稱的定義。初步總覽的主要部份，是有關承建商一般須遵守的規範，包括：(1) 維護項目工程和工地；(2) 保護現有的公共服務，特別結構和樹木；(3) 保障工人和工程現場的安全；(4) 避免造成任何對周邊環境的滋擾；以及 (5) 指明對工地人員、承建商呈交方案、用料和工藝的任何特殊要求。初步總覽還指定工地上任何臨時工程和裝備的需求，包括那些進出道路、工地辦公室、圍板及棚架。此外，還規定了要協助所有指定分包商、專門承建商、政府部門和公用事業在工地現場上完成合同工程。

Contents of Specifications

In writing the specifications, the following should be specified in each trade: (1) design requirements, (2) materials and submissions, (3) workmanship, and (4) testing and commissioning.

施工規格的內容

編寫施工規格時，各個行業中均需要規定下面各項，包括：(1) 設計要求；(2) 材料及方案呈交；(3) 工藝；(4) 測試和調試。

Design requirements

While the majority of the work is designed by the architect or the engineer, there are some items for which the contractor's design input is required to better suit his or her construction methods or where some specialist supplier's items are being used, such as precast façade, curtain walling, skylight, windows, kitchen cabinet, drywall partition, playground equipment, or shop front. In the specifications, the design parameters and the performance requirements of these items have to be stated. The contractor will be required to submit design drawings and a method statement for the installation for the architect or the engineer's approval.

Some of the design parameters, such as dimensional tolerances in construction, or wind loading requirements, or building services requirements for certain elements, have to be specified in the specifications to govern the quality of the contractor's construction product and the performance requirement during the construction process.

設計要求

雖然工程的主要部份是由建築師或工程師設計的，但亦有少部份項目是需要承建商協助設計，以配合他的施工方法，或是當使用一些專門供應商的產品時，例如：預製外牆、幕牆、天窗、窗戶、廚房櫥櫃、乾牆間隔、遊樂場設備、店面等。這些項目的設計參數和性能要求，都需要在施工規格裏予以說明。承建商亦須就該等項目提交設計圖紙和施工組織設計給建築師或工程師批核。

Table 5-1 Example of writing design requirements for structural concrete work
表5-1 編寫結構性混凝土設計要求的例子

DESIGN REQUIREMENTS
Loadings for design and construction
Design and construct formwork and falsework to withstand the worst combination of the following without causing bulging or deflection:
(i) Total weight of formwork, reinforcement, and wet concrete.
(ii) Construction loads, including dynamic effects of placing, compacting, and construction traffic.
(iii) Wind loads.

Extracted from Architectural Services Department (2012), *General Specification for Building 2012 Edition*. Retrieved 10 June 2017, from https://www.archsd.gov.hk/media/15041/e225.pdf.
摘自建築署（2012），《2012年版建築物的一般規格》。見https://www.archsd.gov.hk/media/15041/e225.pdf。瀏覽日期：2017年6月10日。

另一方面，一些項目元素的設計參數，如建造時的尺寸寬限，或風力載重，或屋宇裝備的要求，都必須在建築規格中指明，才能有效監管承建商的建築質量和施工表現。

Materials and submissions

In general, only materials for permanent work are specified in the trade sections of the specifications. Materials and tools assistive to the construction or provision of temporary works are deemed to be provided by the contractor and not necessarily specified in the specifications unless in special circumstances. These items shall be included in the preliminaries as mentioned above.

In specifying the building materials, it is necessary to spell out the requirements on: (a) material types, sizes, finishes, performance, and tolerances; (b) material manufacturing process in quality, environmental impact, and safety standards; (c) testing and commissioning of the material to ensure performance quality; (d) packaging and delivery; and (e) warranty of quality. Instead of writing detailed requirements on every material, very often, references are made to some international standards and national standards. The more common standards used in Hong Kong include ISO (International Organization for Standardization), BS (British Standards), ASTM (American Society of Testing and Materials), EN (European Standards), and GB (Guo Biao, Chinese national standards).

Material samples are usually required for the approval by the architect or the engineer before ordering and implementation on site. The material submissions must be accompanied by supporting documents to prove the standard of quality, which include the submission of: (a) shop drawings; (b) material certificates, such as green product certificates; (c) manufacturer's quality compliance certificates, such as ISO 9001, ISO 14001, ISO 50001; and (d) material testing certificates for quality. After the materials have been installed, the architect or the engineer may require the contractor to provide as-built drawings. All these requirements need to be specified in the material section under each trade.

材料及方案呈交

除了在特殊情況下，施工規格一般只會指明會在落成項目中採用的物料，而一般施工時使用的輔助物料和工具，或臨時工程，都是由承建商提供而不用在施工規格中列出。這些項目應列入初步總覽內。

在指定物料時，必須闡明以下要求：(1) 物料類型、飾面、性能、尺寸和寬限；(2) 製造物料過程中的質量、對環境的影響、安全標準；(3) 物料的測試和調試，以確保物料的質量；(4) 包裝和運送；(5) 品質的保證等。很多時候，我們都會引用一些國際標準和國家標準，而不需寫上每一樣材料的具體要求。在香港較常使用的標準包括：ISO（國際標準化組織）、BS（英國標準）、ASTM（美國測試和材料協會）、EN（歐洲標準）和 GB（中國國家標準）。

物料樣品通常需要在物料訂購和現場施工之前，獲得建築師或工程師的批准。提交物料時，必須伴隨著證明文件，以確定其質量標準。當中包括：(1) 製配圖；(2) 材質證書，例如綠色產品證書；(3) 製造商的質量達標證書，如 ISO9001、ISO14001、ISO50001；和 (4) 物料質量的測試證書。物料安裝後，建築師或工程師可能需要承建商提供竣工圖。所有這些要求都必須在各工種的物料部份列明。

Table 5-2 Example of writing specification on materials for timber doors
表5-2 編寫木門物料施工規格的例子

MATERIALS: Timber doors

Doors shall be 45 mm thick hollow or 50 mm solid core flush doors covered with selected hardwood veneer or laminated plastic sheet on both sides and hung to rebated timber frames.

Appropriate number and types of door hinge shall be provided depending on the size and weight of doors used.

When specified, hardwood louvre and frame shall be fitted to the door.

Extracted from Architectural Services Department (2012), *General Specification for Building 2012 Edition*. Retrieved 10 June 2017, from https://www.archsd.gov.hk/media/15041/e225.pdf.

摘自建築署(2012),《2012年版建築物的一般規格》。見https://www.archsd.gov.hk/media/15041/e225.pdf。瀏覽日期:2017年6月10日。

Workmanship

Like building materials, there are many international standards detailing the workmanship requirement for each trade. However, they may not be completely applicable to the local construction industry. Understanding the local trade practice, identifying problems, and finding feasible solutions to achieve the required workmanship demand research and communication with the contractor. This is important to ensure that what is specified can be achievable; otherwise, it is impossible to monitor the quality of workmanship.

In the specifications, requirements on: (1) site preparation and installation work; (2) sample workmanship using mock-ups for approval; (3) installation procedures; (4) quality assurance plan; (5) site safety plan, environmental management plan for the installation work; and sometimes (6) qualification of the site personnel for the proper execution of the work are included in the workmanship section under each trade.

工藝

每個工種對工藝的要求,如同物料一樣,都有很多國際標準規範。然而,它們未必完全適用於本地的建築行業。要達到所需的工藝要求,我們必須透過研究和與承建商溝通,並明白本地行業的慣常操作,了解問題所在並找出可行的解決方案。重要的是規格裏的要求,必須是可以操作的,否則,便無從監督工藝的質量。

在施工規格上,要列明對各工種工藝的要求,包括:(1) 現場準備和安裝工作;(2) 利用施工樣板作為工藝樣品的審批;(3) 安裝程序;(4) 質量保證方案;(5) 施工時的工地安全計劃、環境管理計劃;及有些時候,(6) 適合執行合同工程人員的資歷。

Table 5-3 Example of writing specification on workmanship for door frames
表5-3：編寫木門框工藝施工規格的例子

WORKMANSHIP: Door Frames
Timber door frames shall be securely fixed to the partition framework with diagonal braces on each side to stabilize the mid-height point of the frame. Door frames at corners and tee junctions shall be positioned to allow sufficient clearance between the back of the door and the intersecting partition to allow the mounting of a surface-mounted door closer and enable the door to open a full 90 degrees without the closer body striking the intersecting partition face.

Extracted from Architectural Services Department (2012), *General Specification for Building 2012 Edition*. Retrieved 10 June 2017, from https://www.archsd.gov.hk/media/15041/e225.pdf.
摘自建築署（2012），《2012年版建築物的一般規格》。見https://www.archsd.gov.hk/media/15041/e225.pdf。瀏覽日期：2017年6月10日。

Table 5-4 Example of writing specification on testing requirement of tile grouting
表5-4：編寫測試瓷磚填縫的例子

TESTING: Tile grouting
The quality tests for tile grouting shall be as follows:

Test items	**Test method**	**Acceptance standards**	**Remarks**
1. Linear shrinkage	ANSI A–108/A1 18/ A136.1-2011	1 day shrinkage < 0.1% 7 days shrinkage < 0.2%	Cast and store grout specimens at 21°–25°C, 45–55% R.H.
2. Water absorption	ANSI A108/A13 601-2011	From 50% R.H. to immersion < 5% From immersion to dry < 7%	Determine water absorption from 50% R.H. to immersion and from immersion to dry

Extracted from Architectural Services Department (2012), *General Specification for Building 2012 Edition*. Retrieved 10 June 2017, from https://www.archsd.gov.hk/media/15041/e225.pdf.
摘自建築署（2012），《2012年版建築物的一般規格》。見https://www.archsd.gov.hk/media/15041/e225.pdf。瀏覽日期：2017年6月10日。

Testing and commissioning

Testing and commissioning are important for quality assurance of the work. All quality testing and commissioning testing requirements, including the number of sampling tests, the type of testing required, detailed procedures of each test, requirements on third-party testing institutes, must be specified under the testing and commissioning section of each trade.

In addition, consideration should be given to specifying the criteria for any necessary retesting and remedial work required when the tests fail. The number of samples for retesting, procedures, and penalty should also be specified.

測試及調試

測試及調試是工程中重要的質量保證。所有的質量測試和調試要求，包括取樣測試量、所需的測試類型、每個測試的詳細過程、對第三方測試機構的要求等，都需要在各個工種的測試與調試中規定。

除了列明測試與調試的要求外，也應考慮加入當測試失敗後所需要的重新測試和善後工作；還應該指明重新測試樣本的數量、程序和處罰條款。

Writing Specifications

Since specifications are part of the contract document, the language used must be concise and precise. It should be clearly understandable, without ambiguity, and well-coordinated with the drawings, BQs, and other contract documents. All terms used and references made should be consistent throughout the specifications and contract documents. As the purpose of the specifications is to inform the contractor about the end product which the architect or engineer designs, it is addressed to the contractor only. Other items, or issues, although within the project but outside the scope of the work, such as the work of the nominated subcontractors, should not be specified in the contract, apart from drawing the contractor's attention to their existence. In specifying materials, research should be carried out to ensure the material is available in the market with enough suppliers to avoid monopoly. In specifying workmanship, it is advisable to have a dialogue with the local industry to work out an implementable way of installation before putting it in the specifications. If we specify material and workmanship making reference to international standards, it is necessary to check that acceptance testing equipment and laboratories are easily available in the industry. Any requirement on materials and workmanship that cannot be verified for their acceptance will not be enforceable under the contract and therefore should not be included in the specifications. There shall also be reasonable penalty clauses for any substandard material and workmanship, to ensure quality of work from the contractor. However, and of equal importance, there shall be bonus clauses to encourage the contractor to make innovative contributions to the contract. After all, a happy contractor will deliver a good project.

編寫施工規格

由於施工規格是合同文件的一部份，所以使用的語言必須簡潔和準確，易於明白，毫不含糊，並與建築圖紙、工程量清單以及其他合同文件一致。所有條款、參考資料，應該在整個規格和合同文件內統一。由於施工規格的目的，是建築師或工程師用來告知承建商其對建築設計的要求，故此，只應針對承建商而寫。其他項目或議題，儘管可能是項目以內，但是在合同工作範圍以外的，如指定分包商的工作，除了讓承建商知道他們是與合同工程有關外，其餘的都不應該在施工規格中出現。在指定物料時，應進行研究，確保該物料可在市場上有足夠的供應，以避免壟斷。在指定工藝時，最好先與本地業界溝通，商討切實可行的方案，才把它制定在規格裏。如果我們是參照國際標準來指定物料和工藝，務必確定驗收測試的設備和實驗室能在行業內容易找到。任何物料和工藝的要求，如不能核實他們的質量，將會無法按合同執行監管，而這些不能監管的要求，都不應納入施工規格內。對任何不合標準的物料和工藝，應適量加入處罰條款，以確保承建商的工程質量。但同樣重要的是，施工規格中應該設有獎勵條款，鼓勵承建商對工程合同作出創新貢獻。畢竟，一個愜意的承建商更能完成一個優質的工程項目。

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