

# CONSERVATION TECHNICAL HANDBOOK

A GUIDE FOR BEST PRACTICES

## Volume 1 | Introduction



# Conservation Technical Handbook

## Volume 1 | Introduction

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### **URBAN REDEVELOPMENT AUTHORITY**

#### **Project Team**

#### **ICOMOS SINGAPORE**

Ho Weng Hin

Tan Kar Lin

Wong Chung Wan

Yeo Kang Shua

Meranda Tang Ying Zi

Ryanne Tang Hui Shan

Foo Chin Peng

#### **URA**

Chou Mei

Teh Lai Yip

Tan Huey Jiun

Kelvin Ang

Loy Ju-Lin

#### **Book Design**

Meranda Tang Ying Zi

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*Cover photography by Randy Loh of Tiptoe Imaging:  
Second storey interior of the Rectory of Cathedral of  
the Good Shepherd during restoration works.*

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## Preface

Urban Redevelopment Authority, as the national land use planning and conservation authority, is pleased to present this series of conservation handbook. Through judicious planning, Singapore has conserved more than 7,000 buildings and structures since 1989. They cover different building types, architectural styles, scales and genres. They are our precious legacy that must be protected for current and future generations of Singaporeans.

This new series is a culmination of URA's collaboration with ICOMOS Singapore, our local chapter of the International Council on Monuments and Sites. This worldwide non-government organization is the official Advisory Body to UNESCO, advising the latter on heritage, conservation and preservation matters and issues. It taps on the technical expertise and experience of ICOMOS Singapore members to take the protection of our heritage gems to a higher level.

The eight volumes in the series are designed as step-by-step guides to carry out best practices in conservation. They will aid those undertaking works on heritage buildings. They contain a wealth of insights gleaned from projects in and around Singapore, taking into account climatic conditions, materials available in the market, new techniques brought by technological advances, and the types of skills offered by the industry.

I hope building owners, developers, professionals in the industry, builders and others who are interested in this field will find this series rewarding. I believe we can foster a strong partnership to protect our heritage. Together, we can make Singapore not just a distinctive liveable city, but also a home that holds meaning for us all.

**Chou Mei (Ms)**

Group Director (Conservation & Urban Design)  
Urban Redevelopment Authority

## About This Series

Since the 1970s, when historic monuments were first granted legal protection and the first shophouses were rehabilitated, architectural conservation has evolved and taken root in Singapore. Heritage buildings form a significant part of our urban landscape today, as brick-and-mortar repositories of memories straddling generations and as treasured focal points for diverse communities.

In the early days, the main challenge was overcoming the prevailing perception of these historic buildings as crumbling, unsanitary and inefficient structures worthy only of demolition (though in need of rehabilitation, they are embodiments of artisanship, history, and urban character). Another uphill battle was the polarized view that conservation is a zero-sum game in terms of economic growth and urban development (it is an indispensable component in all creative, dynamic, well-loved, liveable and competitive cities).

With growing appreciation and awareness of heritage, many have since come around to the idea that conservation is not about fighting change but about how it is managed. Across the city, historic neighbourhoods have found a new lease of life as places to live, work and play, and a growing number of national monuments have been carefully restored in recent years.

While much progress has been made and lessons learned in the past four decades, there is still much room for improvement in skills and knowledge of best conservation practices. This guide is intended to help bridge this gap by laying out the ways to identify and appreciate heritage attributes, understand historic materials and assess their condition, as well as the methods and principles of restoration and long-term maintenance.

This introductory volume touches on key historic building types and materials found in Singapore, and gives an overview of common deterioration phenomena as well as assessment and restoration approaches. There is a summary of the local regulatory context and different categories of conservation gazetting. A brief look at the key international heritage charters and principles provides reference for how conservation thinking and ideals have evolved and matured on the worldwide professional platform. Finally, a handy glossary of common terms is included to dissect and clarify concepts such as 'reinstatement' (for specific missing elements) or 'adaptive reuse' (where the building is remodeled to accommodate new functions). Subsequent volumes go into different aspects of a heritage building, such as the roof, façade, structure, doors and windows, interiors, services, and building coatings.

Built heritage can be seen as a public good, and every stakeholder – including the owner, developer, authority, building professional, builder and user – serves as a custodian of these precious assets. There is shared responsibility to safeguard each historic structure and ensure its safe passage onwards to the next generation. This series is conceived to provide guidance along the way.

**Dr Kevin Y.L. Tan**  
President  
ICOMOS Singapore

## ABOUT ICOMOS SINGAPORE

Founded in 1965, the International Council on Monuments and Sites (ICOMOS) is an international association of over 10,000 cultural heritage professionals working in over 100 countries to conserve and protect the world's important monuments and historical sites. The only global non-government organization of its kind, ICOMOS is an official advisory body to UNESCO. On 14 May 2014, the ICOMOS Executive Committee sanctioned the establishment of a National Committee for Singapore. ICOMOS Singapore consists of a group of multidisciplinary heritage professionals who have for many years worked closely on government and non-government projects involving Singapore's heritage and historical sites and monuments.

For more information, please visit [www.icomos-sg.org](http://www.icomos-sg.org)



Look out for margin notes such as this one, which will give you further advice or link you to other parts of the book.

What do the icons mean?



General tips and advice



Concepts learnt in other chapters



Worksheets are available in the RESOURCES section



External references and hyperlinks



Further reading

## How to Use This Volume

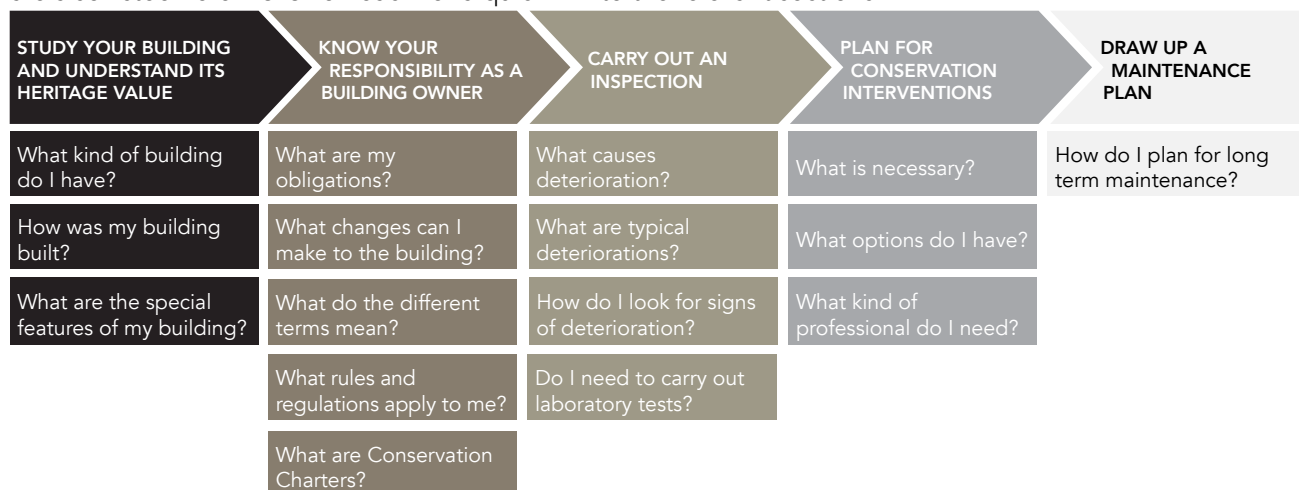
**Volume 1: Introduction**, the first of an eight-volume **Conservation Technical Handbook** series, covers the first steps in conserving heritage buildings and preliminary information to get you started. Handy resources can be found at the back of this book, including a glossary of terms, checklists and further reading.

**Part I** of this volume addresses research, documentation and planning for conservation works. *Chapter 1: Understanding Your Building's Historic Significance* provides a quick glance at the different types and special elements of heritage buildings that are found in Singapore. If you are a heritage building owner, this chapter is designed to help you study and understand the heritage value of your building. *Chapter 2: Planning Works for Your Heritage Building* explains principles that underpin decision-making in conservation, to help you establish priorities and understand the available options when embarking on conserving works.

**Part II** looks at common deterioration in historic structures, and how to address them. *Chapter 3: Understanding the Main Causes of Deterioration* and *Chapter 4: Assessing the Condition of Your Building* explains how your building weathers and ages, and how to inspect and identify problems in your building. Finally, *Chapter 5: Restoring Your Building* provides an introduction to key restoration methods in line with worldwide best practices that address the problems your building encounters.

### HAVE A QUICK QUESTION?

The chapters are broadly organized according to the keys steps you should take when considering conservation works for your building, as summarized in the flowchart below. Some frequently asked questions are also listed here – **click** on each for a quick link to the relevant sections:





PART I  
**UNDERSTANDING  
AND PLANNING**



1 |  
**UNDERSTANDING  
YOUR BUILDING'S  
HISTORIC SIGNIFICANCE**

## Getting to Know Your Heritage Building

Historic buildings are products of a different time, culture and society, created using tools, materials and skills that may have been the mainstream then, but no longer the norm today. Assumptions about current day building design, construction and maintenance are largely not applicable when dealing with heritage buildings. In fact, carrying out current conventional practices on historic structures may worsen deteriorations or even cause long term damage.

For example, applying generic cement-based plaster that is impervious on 19th century brick walls that are meant to 'breathe' will cause moisture to be trapped within, leading to brick damage in the long run. Similarly, incompatible new programmes or insensitive design interventions in adaptive reuse works may result in the alteration of the building's historic and architectural character, and loss of heritage value.

This is why it is critical to establish a good understanding of your heritage building through research and on-site study, including its architectural character and material properties, prior to making decisions regarding its redesign, renovations, repairs and maintenance. This is to ensure that informed decisions are made that will retain, protect and optimise your building's heritage value.

While a select few high key monuments and historic landmarks may already have had some research done, most heritage structures have not been well studied. Any available studies should also be updated and supplemented where information is lacking.

Along with research, comprehensive documentation of your heritage building should be considered the first step of conservation. This will provide a base reference for the 'as found' condition of the building, including the intactness of heritage elements and finishes, that may be affected by upcoming works.

This chapter provides guiding notes and basic information to help get you started on studying and learning about your building and its heritage value.

## Historical Research | Desktop Study

The *National Archives of Singapore* has a rich repository of drawings, photographs, and oral history interviews of many heritage buildings and sites in Singapore. If your building has undergone recent renovations, drawings may also be obtained from the Building Construction Authority (BCA). 

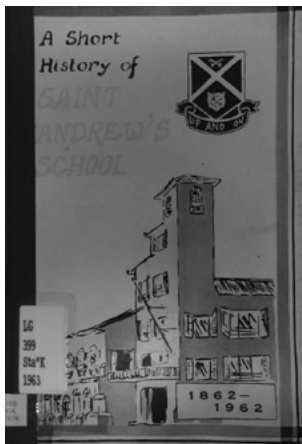
Before starting any restoration works on your heritage building, research into the history of your building and its neighbourhood can help establish its heritage significance, inform what is important to conserve, or what you need to prioritize. As much as possible, try to locate the following documents, which will give you a good insight on your building:

- Archival drawings showing the original design or early alterations - may include information such as materials, construction, etc
- Old maps showing the historical context and how the neighbourhood may have transformed
- Historic photographs from the archives or publications
- Old newspaper articles, for example reports on a public building's grand opening
- Other published records of historical events, the original design and construction

Useful sources to consult include the archives, history publications, old photos, commemorative publications, journals, or newspapers deposited at libraries. If possible, you may also want to interview past owners and users, who have recollection of past events, how the spaces were used and insights into the quirks of your building.

Upcoming sections in this chapter will cover an introduction to **Historic Building Types** and **Historic Construction and Materials**, that should provide useful starting points for your research.

Desktop research studies should always inform, and be verified against, site findings, and vice versa, for a more complete, layered and accurate picture of the building's history.



Example of an old commemorative publication deposited at a local library



Try out the exercise '*Noting Down Physical Characteristics of Your Heritage Building*' in Chapter 1. Then, compare your notes with the archival documents that you have uncovered to help you understand what are original historic parts of your building, and how it has changed through the years.

## Noting Down Physical Characteristics of Your Heritage Building | On-Site Study



Are you a building owner? The sample checklist '*What Is Unique about My Building?*' will guide you along this exercise.

This is a simple exercise involving a walk around and within your building, observing it at far and close range, and noting down its various physical characteristics. These could be grouped into the following four main aspects – form, façade, materials and details, interiors.

Noting down your heritage building's specific physical attributes and unique visual or tactile qualities will help you appreciate it better as a work of architecture and craftsmanship that will likely not be replicable today. This exercise will also help provide a basis for assessing the necessary scope of conservation investigation and repair – for example, certain deterioration issues are commonly associated with specific building materials.



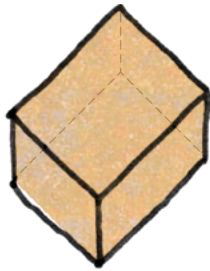
*A building could be composed of a combination of shapes, such as this shophouse at Circular Road, which is triangular in plan and has a tall tower at one corner.*

### FORM

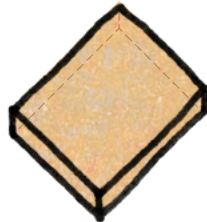
Depending on the size of the building and its surrounds, a far-range visual survey can be done by taking a 'bird's eye view' from the nearest publicly accessible tall building to understand its **roof form, massing** and **footprint**. You could also walk around the building for far views – say, from across the road – to appreciate its **height** and **number of storeys**. These observations will establish the building's broad silhouette. Common roof forms include flat, double-pitched, single-pitched, hipped and pyramidal. A building's footprint refers to its shape on plan, and determines how interior spaces and circulation are organized – for example, shophouses have long, narrow plans punctuated with airwells. Massing relates to the volumetric composition of a building, and descriptors include slab, L-shape, T-shape, U-shape or H-shape blocks, or combinations such as podium-and-tower. Refer to the following page for some basic building shapes and forms you may encounter.

### FAÇADE

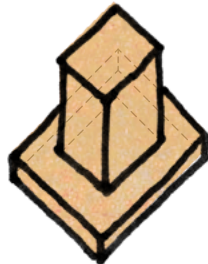
A building's main façade is usually its most publicly viewed face, and would likely have been given much thought in design on aspects such as proportion, symmetry, motifs, harmony with its context, and so on.



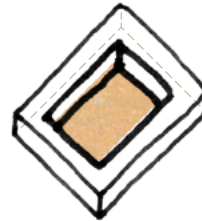
BLOCK



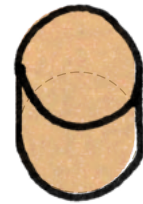
SLAB



PODIUM & TOWER



COURTYARD



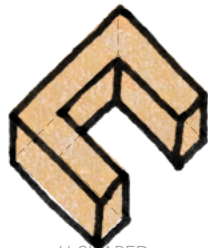
CYLINDER



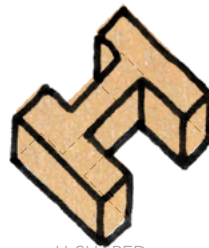
L-SHAPED



T-SHAPED

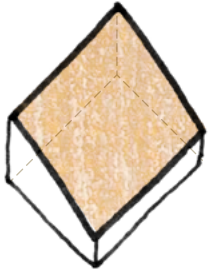


U-SHAPED

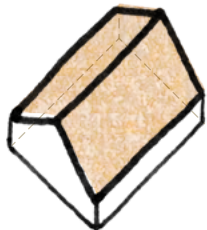


H-SHAPED

**SHAPES/ FORMS/  
MASSING**



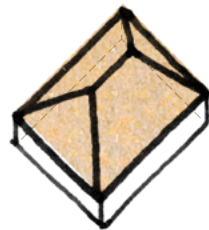
SINGLE PITCHED



DOUBLE PITCHED



CROSS-GABLED



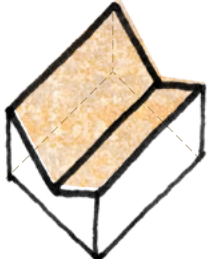
HIPPED



CROSS-HIPPED



SWEEPING



BUTTERFLY



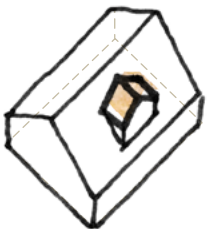
SALTBOX



MANSARD



HIPPED GABLE



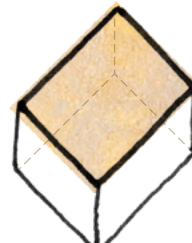
DORMER



DOME



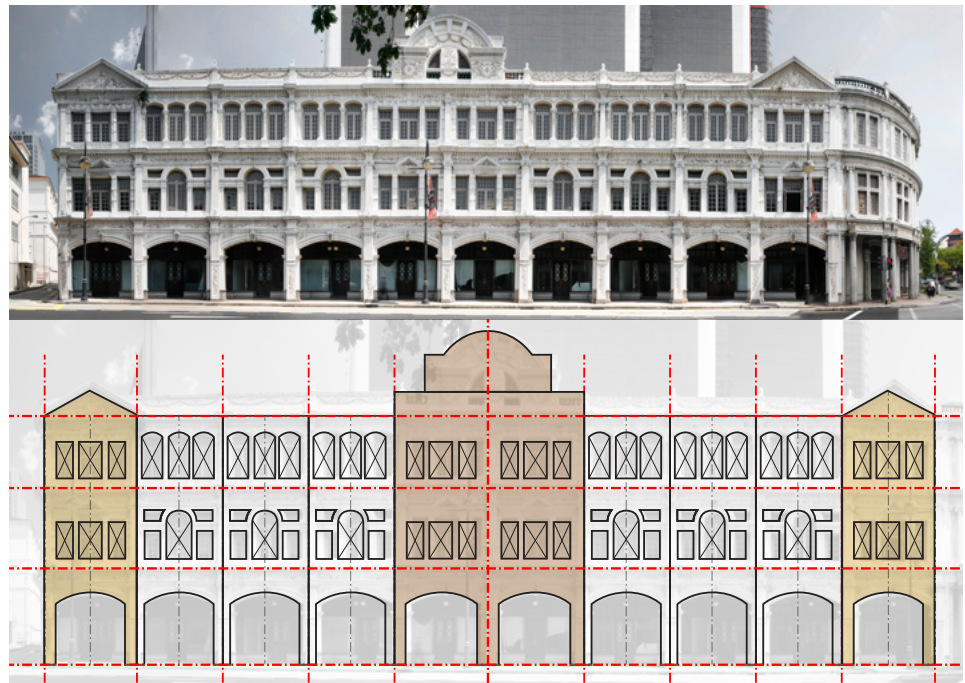
TURRET



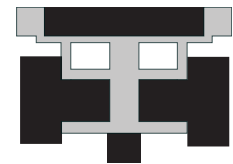
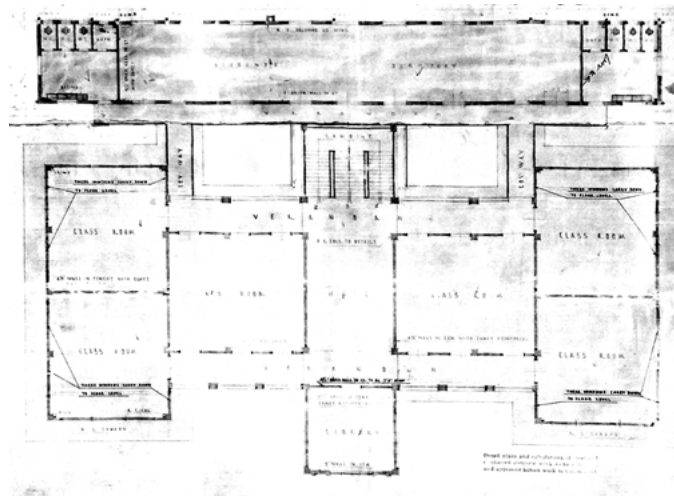
FLAT

**ROOF FORMS**

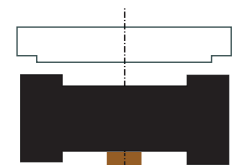
An example of how a façade could be analyzed, looking at divisions, window shapes, types, patterns, symmetry and overall composition.



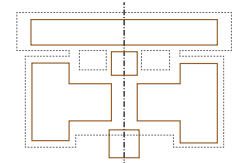
An example of spatial relationships found in a building.



Main vs Support Spaces



Hierarchy



Symmetry & Balance

Besides the height, width and outline shape, other main features of a façade are the number and type of **openings**, whether there are **projections/recessions**, its overall **proportion** and **composition**. Openings could refer to doors, windows or vents. While vents often come with fixed louvre, grating or screen panels, doors and windows usually have openable panels in timber or metal frame that may be glazed. Examples of façade projections are balconies, bay windows and sunshading fins, while recessions include five-foot ways.

Depending on whether it is a standalone, semi-detached or terraced building, it may have side elevations, and usually a back façade. These are not necessarily less important façades; for example, a beach bungalow may have a solid and formal street-facing façade, and a different but equally elaborate seaward elevation at the back with deep verandahs for enjoying the breeze and the view. As another example, a shophouse back lane may feature a row of spiral escape stairs at the back façade of all units that is part of the buildings' key heritage character.

## MATERIALS AND DETAILS

A key asset of your heritage building is the material finishes on its walls or columns, roof, floor, and ceiling. During the close-range survey, take note of the range of materials and their quality, workmanship, texture and colours. The historic material palette of a heritage building is often its most overlooked and fragile attribute, as it is easily damaged, altered or concealed through weathering, lack of maintenance, or insensitive renovations such as replastering or painting over previously fair-faced finishes. However, it is also an irreplaceable attribute that gives the building tactile and visual character and a sense of historic authenticity.

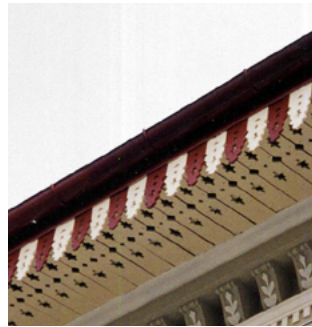
Common historic materials found on walls include lime- or cement-based plaster, Shanghai plaster, fairfaced brick and tile; roofs are often finished in profiled tiles and metal sheets; floor finishes may include stones such as granite and marble, cement, encaustic tiles, mosaic, terrazzo, timber; ceilings could be in timber coffers, stamped metal sheets or plaster.

A close-range survey would also be helpful to document historic ornamental details such as mouldings, murals and motifs, and historic fittings like ironmongery, rainwater goods and so on.

See 'Historic Construction and Materials' to find out how your building's material palette relates to its history.



Examples of special details for which you should keep an eye out.



ORNAMENTED ROOF EAVES



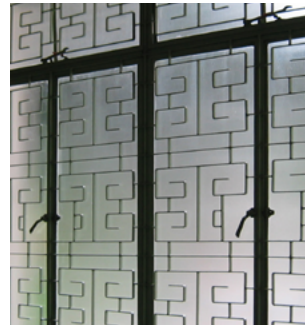
RAINWATER GOODS



TIMBER STAIRCASE



PLASTER MOULDINGS



DECORATIVE GRILLES



IRONMONGERY

Common materials used in historic buildings in Singapore.



LIME PLASTER



SHANGHAI PLASTER



FAIRFACED BRICK



CERAMIC TILES



VENT BLOCKS



MARSEILLE TILES



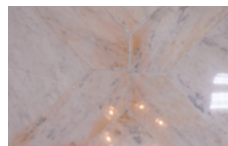
V-PROFILE TILES



METAL SHEETS



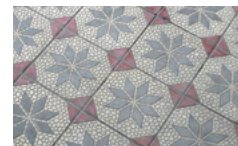
GRANITE



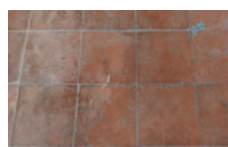
MARBLE



CEMENT



ENCAUSTIC TILES



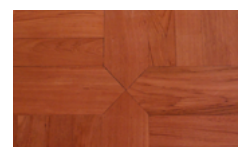
TERRACOTTA



TERRAZZO



MOSAIC



TIMBER

*Church of the Blessed Sacrament (1965): an example of an intact historic interior space.*



## INTERIORS

Unless it comprises a singular interior space with little or no subdivisions, like a chapel or a warehouse, documenting the interiors of your heritage building may not be as straightforward as assessing its exterior aspects. Interior attributes are not as immediately visually apparent and tend to have undergone more transformation as the building inhabitants and function change.

See 'Historic Building Types' to find out what your building's type is.

Identifying the **Building Type**, i.e. the structure as it was originally designed, may help you with understanding its planning layout and spatial organization, such as how a school would be designed with cellular classroom spaces connected by shared corridors.

You could also establish the spatial hierarchy, by identifying main or feature spaces – like public lobbies, passenger halls or drawing rooms, and auxiliary or service spaces such as pantries, storerooms or outhouses. Main or feature spaces are usually more elaborately designed and finished. A room associated with historic events or special memories would be imbued with added social or historic significance.

It is also important to note down connective spaces such as corridors, landings, stairhalls, as well as open spaces like atria, gardens, courtyards, airwells. Some of these may be feature spaces, such as the grand stairways of a theatre foyer.

When surveying each of these interior spaces, note down as far as possible attributes including its shape in plan, height (whether it has a low or high ceiling), original surface finishes, ornamental details and historic fittings.

## Historic Building Types

*The history of a city is recorded not only in books, but also in its buildings.*

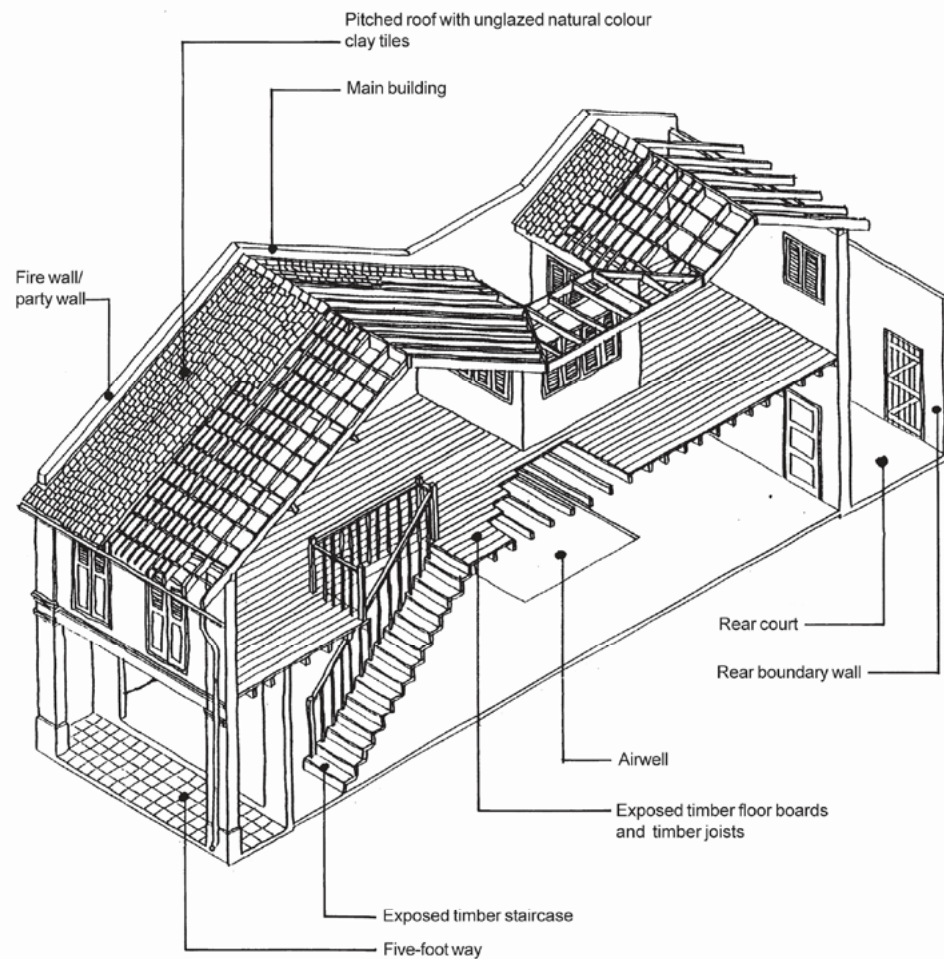
The Late Deputy Prime Minister S. Rajaratnam, Foreword to *Pastel Portraits*

Building types are a function of intended use, available resources, construction technology, cultural-geographical contexts, and other factors like building regulations. Different historical periods and locales are thus characterized by building types produced in their respective milieu. For example, precedents and variations of the shophouse evolved across Southeast Asia, where it proliferated from the 19th to mid 20th century as the ubiquitous colonial city building type, and it currently forms the bulk of Singapore's conserved building stock.

A good understanding of historic building types is crucial to carrying out appropriate and sensitive conservation works and alterations, and deciding on appropriate adaptive reuse, while ensuring the heritage value and attributes are well taken care of. This section introduces some of the key historic building types and their main variations among the conserved buildings of Singapore.

It is important to also note that in the past when urban development took place at a slower rate and resources were less available, buildings tailored for a particular purpose were often modified and put to a different use, rather than demolished. As such, the typologies and associated attributes as described below only serve as a broad guide, and not as qualifying criteria. In fact, when carried out sensitively and skilfully, these past alterations reflect the rich layers of architectural and social history of the conserved building, and should be considered as part of its heritage asset.

Key elements of a typical shophouse.



## SHOPHOUSE/TOWNHOUSE

**Terraced row housing** with a narrow and deep plan was an urban form developed to maximize the number of buildings with desirable frontage, such as shopfronts on a busy street, so as to optimize commercial returns. Southern Chinese urban mercantile architecture and the waterfront Dutch canal houses are manifestations of this building form. Scholars have variously suggested that, introduced respectively through migration and colonization from the 17th century, these gave rise to the shophouse cities in Southeast Asia. Variations have evolved, adapted to a range of climates, colonial planning policies, local building resources and so on.



157 Neil Road is an example of a townhouse. It has similar features to a shophouse, but with a private forecourt.



Barrack housing at Kim Yan Road - a rare intact example that survives today.

Specifically, historian Jon Lim attributed the emergence of the local shophouse typology, characterized by its public five-foot way, to the 1822 Building By-Laws of Singapore by Raffles, which stipulated a uniform front for the street-facing buildings, with a common ground level “verandah” as a “continuous and open passage on each side of the street.” Intended to provide shelter from the harsh tropical sun and heavy rain, these five-foot ways became a dense network of common passageways connecting almost the entire colonial city. It became an important public amenity, characteristic urban feature, and vibrant social space where neighbours hung out, and ‘five-foot way traders’ thrived by servicing a variety of daily needs.

Other common features include party walls between units built of non-combustible materials such as brick, or later reinforced concrete – fire-prevention measures given the high density of the urban form – though floor and roof structures may be in timber. The typically two- to three-storey buildings have courtyards or air wells punctuating the long deep plans to introduce daylight and natural ventilation.

**Shophouses**, as the name implies, were developed as mixed-use buildings – the street-fronting ground floor unit, usually with a singular large opening spanning the entire bay, was used for business, while upper floors were residential. **Townhouses**, while similar in form and appearance, were purely residential, and differentiated by domestic-sized door and window openings on the ground floor. More exclusive townhouses featured private ground floor verandahs or even enclosed forecourts instead of open five-foot ways. These could be private or colonial government housing.

Other variations of terraced row housing include **barrack housing**, which are simple single-storey workers’ accommodation or dormitories provided by private companies or the colonial government.

## BUNGALOW

The bungalow as a housing type has its roots in British India, where the vernacular Bengali timber and thatch hut structure was adapted for colonial dwelling as Europeans ventured into undeveloped land in search of resources and opportunities. The earliest 'Anglo-Indian' bungalows were single-storey structures raised on earthen plinths, characterized by vernacular-inspired climate control features such as large overhanging roofs, generous verandahs and sunshading screens. They reflected the colonial settlers' pursuit for privacy, hygiene, ventilation, comfort and security as they negotiated untamed foreign lands and climates, evolving to become more substantive and permanent structures as cultivated estates and townships were established. As the bungalow type proliferated across other colonies, local variations emerged, and its construction evolved alongside building technology, with increasing use of masonry, iron/steel, and eventually reinforced concrete. In this part of the world, it came to connote more generally a single- or double-storey, freestanding, ex-urban dwelling with a compound.

The earliest bungalow types in colonial Singapore included the **planter's bungalows or plantation villas**, commonly erected in estates around the Tanglin area from the mid to late 19th century. Incorporating features of vernacular Malay houses, the early planter's bungalow in British Malaya was typically raised on posts – for better ventilation compared to a plinth – and topped by a dominant hipped roof with deep eaves. Often located on high ground, the raised house, usually with generous verandahs around the periphery or at both front and back, allowed for commanding views of the estate above grown trees. Elevated above flooding and ground moisture, the main dwelling space was also ensured of ample ventilation and daylight. The space beneath was put to ancillary uses such as storage, children's play area, or office. More permanent brick piers later replaced timber posts, and the ground floor eventually became a full-height storey accommodating additional rooms and sitting areas, with a timber-framed upper floor. This formed the basis for other suburban, rural and coastal houses or holiday homes built as private residences, company lodging, or government and military housing.



*From top: Inverturret at Gallop Road, a plantation villa-type design with the upper floor raised high for surveillance of the grounds; A black and white bungalow at Dalvey Estate, with distinctive black timber frames.*

One visually distinct variation is the **black and white bungalow**, built in the period from the 1900s to the interwar years, and predominantly identified with government and military housing estates designed by the Public Works Department, such as Goodwood Hill and Rochester Park estates. Characterized by black timber frames contrasting against white stucco infill walls in the half-timbered main or upper storey, the bungalow's aesthetic influence has been attributed to the revivalist Tudor style of 19th-century England. However it could also be simply due to the prevalent use of black timber preservative coating on government houses in the period.



*An example of a Malay Bungalow with low piers and an entrance stairway.*

The **Malay bungalows**, on the other hand, are comparatively modest in scale with smaller compounds, and mostly found in middle-class suburban areas that emerged in the interwar years such as Joo Chiat, Geylang and Serangoon. Evolved from the vernacular Malay house with colonial influences such as a tiled roof, brick construction and ornamental plasterwork, these are typically single-storey, and invariably raised on low brick piers due to their low-lying flood-prone locations. A distinctive feature with vernacular roots is the external entrance stairway, often sheltered and leading up to a verandah space.

## FLATS

**Flats or apartments** are single- or double-storey homes that are stacked up to become a larger multi-storey building. Being able to accommodate larger numbers of residents within the same land area than landed housing, this building type optimizes land use, and is usually found in urban locations with high land prices and/or high population density. It is a modern building type that became possible with the advent of high-rise building technology in steel and reinforced concrete, the invention of elevators, as well as modern plumbing that eliminated the need for night soil collection, outhouses and wells. With compact plans and a reduced need for servants to upkeep, flats gained popularity in the 1920s among small middle-class families and single expatriates.



*From left: Eu Court, 1920s prewar private apartments along Stamford Road; Tiong Bahru public housing estate by SIT, 1948–54; postwar civil service staff quarters at Monk's Hill Road*





*One of the earliest high-rise public housing estates by HDB at Cantonment Road (1963), containing over 300 units and completed in just nine months.*



*Private luxury flats, such as the Pearl Bank Apartments (1976), leveraged on the 'high-rise' form to provide exceptional privacy, exclusiveness, comfort and views.*

Units are accessed via common stair or lift cores leading to a shared landing or corridor on each level. Floor plans are repeated across levels, shaped by the efficiency of shared structural bays, chimneys and service stacks for water supply and sewerage. Shared areas such as common corridors and staircase or lift landings form an integral component of apartment design, being social spaces where neighbours meet and interact. Early flats were built by private developers, mostly three or four storeys and located in choice urban sites with high-end shops on the ground floor.

The colonial authorities adopted the building type as **government staff housing** around the late 1920s–30s, such as Pearl's Hill Sikh Police Barracks, that may come with communal facilities such as laundry yards, alongside singles dormitories, family apartments and offices. Tiong Bahru was among the first **public housing flat** estates, developed from 1936 to 1941 by the **Singapore Improvement Trust**. It mainly attracted middle-class families who could afford the monthly rental with their regular income.

High-rise apartment blocks proliferated in the post war years, in the form of SIT and subsequently **Housing Development Board** public flats catering to the masses, and private **condominiums** for the more well-off. Block layout, orientation, scale, open space and amenities became critical in high-rise estate planning to ensure that land use optimization did not compromise a humane living environment. A key feature of HDB flats is the void deck, introduced after 1969 by omitting ground level housing units which were deemed to have compromised privacy and ventilation. It became a multi-purpose space for Malay weddings, Chinese funeral wakes, polling stations, or as a sheltered play area, and was also leased out for community amenities such as childcare and eldercare centres.



From left: High key colonial civic buildings such as the Supreme Court also served to convey the sovereignty of the British Empire, while the state-of-the-art transport structures of Clifford Pier and the Civil Aerodrome (Kallang Airport) demonstrated its technological prowess.



One of the earliest preserved examples of civic buildings include Telok Ayer Market, established in 1825, moved and rebuilt in cast iron in 1894.



Blk 38 Commonwealth Avenue Wet Market is a Queenstown landmark built by SIT in 1963.

## CIVIC BUILDINGS

**Civic buildings**, such as town halls, public offices, hospitals, transport nodes (train stations, airports, piers), community infrastructure (markets, community centres, post offices, fire stations, libraries, clinics), serve a public function and are usually developed by the government.

Notwithstanding the wide-ranging programme, scale and form, the common key characteristics are public accessibility to at least part of the building, convenient location, and when well-designed, an architecture of civic presence that serves as the focal point of a neighbourhood or urban district. Embedded in people's collective memory, the public space component is invariably a character-giving feature of civic architecture, be it the main hall of a train station, a town hall foyer, service counters at public offices, or the waiting lounge of a neighbourhood polyclinic.

In the postwar years, a network of welfare infrastructure including community centres, fire stations and post offices was erected island-wide, including rural areas. **New Town** planning by SIT and subsequently HDB also incorporated civic structures such as markets and clinics to create self-sufficient townships. Some of these, such as the Queenstown Market, became imageable neighbourhood landmarks.

## SCHOOLS

In colonial Singapore, schools were mainly founded and run by community and religious organizations such as church missions, temple or clan associations, as well as philanthropists, with only a handful opened by the government. Most **non-public schools** were accommodated in the organizations' existing space, homes or rented premises and went on to have dedicated campuses only when they became established with expanding enrolment.

Due to the varying patronage, curricula and location, **prewar school buildings** differed widely in appearance and configuration. Nonetheless, there are similarities shaped by function and climate - broadly, these are two- to three-storey buildings with cellular classroom spaces arranged along semi-open 'verandah corridors' and/or around courtyards, designed to ensure ample ventilation and daylight for a conducive learning environment as well as smooth circulation routes for the large number of students. Schools adopting a modernized curriculum with its emphasis on discipline and bodily health would also have an assembly space and sports field.



*Prewar school buildings differed widely in appearance and configuration due to their differing patronage, curricula and location. (Left to right) Chong Hock Girls' School at Chong Wen Ge 崇文閣 (1914), Former Tao Nan School (1906), Alsagoff Arab School (1912).*



*Postwar schools built by the Public Works Department include (left to right): School for the Deaf (1963), a prototypical PWD hall-cum-canteen block added to the prewar Victoria School campus at Tyrwhitt Road (1967), former Tanjong Katong Girls' School at Tanjong Katong Road (1954).*

In the postwar years, along with the attempt to standardize curriculum and make education available to the masses, the Public Works Department (PWD) embarked on an island-wide school building programme. Rather than tailored designs, standard models or types were developed for quick replication on multiple sites and efficient construction. These **postwar PWD schools** were varying compositions of basic components including classroom blocks, a library, an assembly hall, a canteen, and a school field.

## MILITARY

Occupying large, sprawling compounds, **colonial-era army camps** were collections of specialized military structures including fortresses, barracks, drill halls, mess, and arsenals, with supporting facilities such as parade squares, recreational grounds, offices, workshops, warehouses, etc.

Catering to highly structured group living and operations, and usually located away from the public eye, these tend to be simple, minimally ornamented, functionalist buildings. Architectural considerations are focused on environmental comfort and health, with climatic design features facilitating natural ventilation and passive cooling such as high ceilings, extensive vents and deep eaves. Early structures such as some of the 19th-century barracks in Tanglin are lofty, single-storey large span shelters, constructed of masonry columns and timber roof trusses. **Barracks** and **messes** built in the interwar years, such as those found in Changi, are two- to three-storey masonry and reinforced concrete structures with imposing symmetrical facades and restrained ornamentation.

*From left: 19th-century barrack at Tanglin with lofty ceiling and large timber roof on masonry columns; two-story structures at Blakang Mati Artillery Barracks, Sentosa, 1904.*





From left: St. Teresa Church (1929), Ramakrishna Mission (1940s–50s), Sultan Mosque (1932).

## PLACES OF WORSHIP

Religious venues form one of the earliest building types established in colonial Singapore, fulfilling the spiritual and social needs of early settlers. Reflecting the multi-ethnic colonial society then, historic places of worship found in Singapore are highly diverse in form and content, including **Buddhist, Taoist and Hindu temples, ancestral prayer halls, Christian churches, mosques, and synagogues.**

Often beginning as ad hoc sheds, small shrines or borrowed spaces, they provide a safe haven for members of the same religion or clan to practise their faith as well as meet, pool resources and organize themselves. As the respective communities grew and prospered, and more resources became available, these institutions evolved and grew, erecting permanent, dedicated buildings. They may be located within the community they serve, such as rural churches where missionaries reached out to plantation workers and villagers. The sites may also be symbolic, such as originally sea-facing Thian Hock Kheng, housing the protective deity of seafarers, and Sultan Mosque in Kampong Glam, next to the royal palace in the colonial-designated Malay settlement.

Migrant religious architecture is mainly informed by the particular faith, its spatial and ritualistic needs, and the building tradition of the worshippers' homeland. For example, ablution areas would be integral to mosques, synagogues and Hindu temples. Also, most Buddhist or Taoist temples were built in the traditional Southern Chinese style, given the provenance of most worshippers. To address the lack of specialized artisans and materials in the colony, these would sometimes be imported, especially for high key components such as Chinese temple roof shard work, and church stained glass windows.

In the context of a laissez-faire colonial government, the religious institutions assumed an expanded role providing community welfare, education and healthcare. These functions may be housed within the same site – a complex with classrooms, clinics and lodging centred around the main venue of worship. Examples include the grounds of St. Joseph Church, which encompassed an orphanage and a school run by the Portuguese Mission, as well as Ramakrishna Mission, which still hosts a kindergarten, boys' home, and dormitory.

## INDUSTRIAL

Industrial buildings and sites cater to different stages of the industrial process, where raw materials are extracted (**mines** and **plantations**), processed (**factories, mills** and **kilns**), and stored (**warehouses** or **godowns**). They also include supporting infrastructure providing transportation (**ports** and **railway stations**), electricity (**power stations** and **dams**), and ancillary buildings such as maintenance yards.

Examples of industrial structures and landscape in colonial Singapore include granite quarries at Bukit Timah and Pulau Ubin, nutmeg, rubber and pineapple plantations with processing plants and warehouses, godowns and trading houses served by Singapore River, brick kilns near clay sources at Bukit Merah and Tanjong Rhu, repair yards at Tanjong Pagar Railway Station and Sembawang Naval Base, St. James Power Station, and Kallang Gasworks.



From left: Clarke Quay Godowns, Sembawang Shipyard, St James Power Station.



The soaring interiors of the Kallang Airport Hangars, one of the largest structures of its kind in the region when completed.

Modernist ideals of a humane industrial work environment as realized in BEP Akitek's design for Far Eastern Press (1960s).



The distinctive concrete silos at Prima Flour Mill.

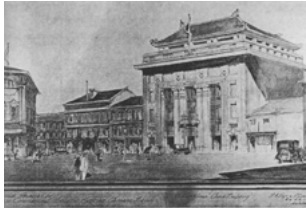
Industrial architecture reflects and serves the need for economy of scale, efficiency and productivity. Typical industrial buildings, such as factories, workshops or warehouses, were designed with expansive column-free space and lofty headroom, to accommodate large numbers of raw and processed goods, line workers and machinery, as well as facilitate workflow. Large windows or clerestories, and jack roofs or saw-tooth roofs with skylights ensured the factory floors were well-lit and ventilated, optimizing workers' comfort and productivity.



Lea Hin was one of the early local mild steel component manufacturers. Its headquarters building is clad in a distinctive sunshading screen of mild steel grid and stars.

Industrialization also enabled the development of stronger building materials – such as modern steel, concrete and glass – which in turn gave rise to state-of-the-art industrial structures with monumental spans, expansive glazing and innovative forms, as exemplified by Kallang Airport Hangars. Specific technical requirements gave rise to specialized structures, such as rubber smokehouses with towering chimneys, brick-firing kilns, grain silos and so on.

While functional requirements usually take precedence, industrial buildings may also present the public front or work values of the company, especially for the front office or showroom components. **Godowns/warehouses** at Clarke Quay and Robertson Quay featured ornamented façades as a genteel 'shopfront' to what was essentially a large storage space. Some industrial architecture conceived in the postwar years embraces the socialist design ideals of the period, such as the garden setting, rational planning, and humane design of the Far Eastern Press compound.



*The façade of China Building (1932) displayed the prominence and prestige of the Oversea-Chinese Banking Corporation housed within.*



*Urban intensification resulted in the emergence of tower forms in the business districts, such as the redevelopment of China Building into OCBC Centre (1976).*

## COMMERCIAL

Commercial buildings were designed to house businesses, such as **trading houses, banks, department stores, offices** and **hotels**. These could be built by the business-owner themselves, or could be speculative properties developed to generate profit from rental. Buildings tailored for established corporations would usually emphasize the design of their façades and public areas, to align with the prestige and image of their occupants, a prime example being bank headquarters. In urban commercial zones, developments would be further shaped by steep land prices, maximizing the height and floor area as far as building budget, regulations and technology allowed. This has led to the cyclical urban intensification and dominance of towers in business districts.

The **Commercial Square** (later renamed Raffles Place) was designated as the European business district in Raffles' 1822 Town Plan, on the south bank of the Singapore River in close proximity to where goods arrived by sea. Following the establishment of the colonial free port, many trading houses set up their godown-offices in the area. As the colony developed, such low-density storage facilities were soon displaced to the quays farther upstream, while Commercial Square intensified and became the coveted address for prestigious banks, agency houses, professional services and department stores.

**Office buildings** before the days of affordable air-conditioning and electrical lighting had to be designed for indoor comfort, passive ventilation, and ample diffused daylight while avoiding glare, to create a productive work space. Early multi-storey office buildings typically had narrow floor plans, high ceilings, and generous openings to optimise natural lighting and cross-ventilation. The typical floor would be subdivided into cellular spaces for multiple tenants, or left as an open-plan office for large organizations. Staircases, corridors, and utility areas such as washrooms were shared and usually recurred at the same location on each floor for efficiency, creating circulation and service 'stacks' or 'cores'. As new technology enabled increasingly taller 'skyscrapers', architects experimented on the buildings' proportion, massing and articulation, a distinctive example being the 18-storey art deco Asia Insurance Building (1955), once the tallest tower in Southeast Asia. Though largely comprising regular office space, historic bank buildings were distinguished by a dominant publicly accessible space – the banking hall – and high-security zones containing vaults or safe deposit boxes.





Stately granite columns could still be seen at the prominent street corner of Oranje Building (1904, later known as Stamford House), marking the historic entrance to the ground-floor Whiteaway, Laidlaw & Co. department store.

Early **department stores** such as John Little and Robinsons Department Stores – founded in 1842 and 1858 respectively among the godowns at Commercial Square – probably started as warehouse-showrooms selling goods directly to customers. By the 1900s, as consumption and retail practices grew sophisticated, these had evolved into a specialized building type. Usually located at upmarket locations, featuring refined design and finishes, these had lofty, generous sales floors, carefully planned circulation around tasteful display cases and shelves – well-lit by diffused daylight to show off the array of goods – and perhaps a tea room for shoppers to rest their feet.

**Hotels** provide serviced rooms for short or mid-term stays, with shared or en suite bathrooms, and a range of amenities and services, depending on the hospitality class, such as a common lounge, restaurant, laundry, leisure facilities such as a ballroom, games court, pool, and so on. Resort hotels catering to vacationers usually capitalized on scenic and idyllic surrounds, such as the old Sea View Hotel (1906) at Tanjong Katong. Many of the earliest hotels in Singapore were converted from residences, including Raffles Hotel, which grew organically as subsequent wings were added to the original 1830s Beach House resort. The six-storey purpose-built Great Southern Hotel (1927) was designed with shops on the ground floor, while a restaurant, cabaret, and teahouse occupied the fourth, fifth and roof terrace levels. Tanjong Pagar Railway Station (1932) presents a hybrid example designed with built-in hotel facilities for stopover travellers. High-rise hotels became common from the postwar period onwards, Hotel Malaysia (1968, later known as Marco Polo Hotel) being a key architectural landmark in the 1970s.



While Raffles Hotel (1830s) began as a private residence that was converted into a hotel, Great Southern Hotel (1927) was purpose-built for a hospitality function.



## LEISURE

The colonial European community introduced Western organized sports and hobby groups that gave rise to the earliest purpose-designed leisure structures, such as stadiums erected for spectator games, and clubhouses. Early **stadiums** were essentially grandstand structures erected next to dirt fields, the oldest being the Singapore Sporting Club racecourse (1843) at current-day Farrer Park, precursor to the Singapore Turf Club. As spectator sports gained mass following, the Turf Club moved to the much bigger Bukit Timah compound and built a multi-storey grandstand (1933). Other large multi-purpose stadiums erected included the covered Happy World Stadium (1937) and Singapore Badminton Hall (1952), built for court games but also hosting boxing matches, concerts, movie screenings, trade fairs and political rallies.

The basic **clubhouse** comprises a simple pavilion or bungalow-like structure housing rest areas, storage and changing facilities, with a viewing platform overlooking the activity space, such as a race track, games field, or choice bathing spot along the coastline. Examples include the elite Cricket Club pavilion (1860s–1900s) fronted by the Padang, and the Singapore Indian Association clubhouse (1950) at the Balestier Plains. A number were social clubs providing a range of leisure facilities for members, such as the former Brittonia Club (1952, later known as NCO Club).

*The Brittonia Club (1952, later known as NCO Club) at Beach Road was originally a recreational clubhouse for British servicemen and featured a dance floor, a billiard room, a restaurant, a music room, and the Nuffield swimming pool with a viewing terrace.*



The 1920s saw the colonial government building a series of **public sports facilities**, such as the Jalan Besar Stadium (1929), venue for the Malaya Cup football tournament, and Singapore's first **swimming pool** – converted from an old reservoir – Mount Emily Swimming Complex (1931). Other significant government-built leisure structures include the Yan Kit (1952) and River Valley (1959) Swimming Complexes, and in the post-independence period the former National Stadium (1973).



*Capitol Theatre (1933) was fully equipped with a dedicated projector room for film screenings, and a fly tower for staging live shows.*

Another key leisure building type is the **theatre hall**, where ticketed performances or shows are held. Typically the building has as its main space an auditorium, perhaps with mezzanine seating, and supporting functions such as backstage, ticketing, food and drink concessions. The European-style performance hall, such as Victoria Theatre and Memorial Hall (1904–06) would be fitted with a proscenium stage, an orchestra pit, as well as a grand entrance, an elaborate lobby, and ample socializing space around the foyers, reflecting the social rituals of theatre attendance in the colonial period. Meanwhile, socializing took place within the auditorium in Chinese opera teahouse-theatres such as Lai Chun Yuen (1887), designed with the audience seated at tables, and balconies overlooking the stage, and where it was the norm to eat, drink and chat during performances.

**Cinema** arrived as a new form of leisure at the turn of the century, initially taking the form of a simple open-air projection screen arrangement, and later adapting small live show theatres as screening halls. New theatres built in the interwar years started catering to both live shows and film screenings, such as Capitol Theatre (1933), which has both a dedicated projector room and a fully equipped backstage fly tower.



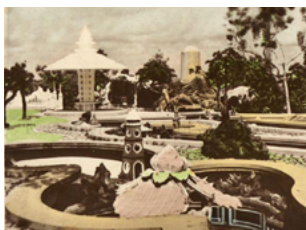
*New World (1923) with two of its cinemas flanking the entrance.*

The expanding middle class gave rise to mass leisure in the interwar years and saw the establishment of several large-scale **amusement parks** – the most well known were New World (1923), Great World (1931), and Happy World (1931). These were more like permanent fairgrounds with popular entertainment as the mainstay programme, featuring a range of formal and informal, sheltered and open air venues for film screening, live shows, taxi dancing, dining and sports games, interspersed with amusement rides and rows of retail, game and soda stands.



Leisure buildings built in art deco style - from left: Cathay Building (1939), Tien Yien Moh Toi (later Majestic Theatre, 1927), and Sky Cinema (1958).

The 'golden age' of leisure architecture in the interwar period and 1950s was marked by the progressive and exuberant **art deco** style, exemplified by Happy World with its impressively engineered reinforced concrete buildings such as the large-spanning Stadium, Cabaret with its high-tech dance floor, and Restaurant with a roof terrace view of the Singapore Civil Aerodrome (later known as Kallang Airport). The Cathay Building (1939) was an art deco landmark, and was also Singapore's first skyscraper and the tallest building in Southeast Asia at the time of its completion. Tien Yien Moh Toi (later Majestic Theatre, 1927), a Cantonese opera theatre, stood out for incorporating Chinese motifs in its rendition of the new style. Postwar-era art deco icons include the Sky and Globe Cinemas (1958) at the Great World and Metropole Cinema (1958).



Haw Par Villa (1937), with its eclectic gardens featuring allegorical statuary tableaux amidst Chinese landscape rockeries, was a private park that eventually became fully open to the public in the postwar years.

Historic leisure sites and structures also include **pleasure parks** – landscaped leisure gardens with manicured terrain and ornamental planting, curated views along strolling paths, peppered with water features, pavilions, follies and sculptures. The Singapore Botanic Gardens was started in 1859 by agri-horticultural enthusiasts as a members-only leisure park. The interwar years saw the creation of other pleasure parks, such as the Alkaff Lake Gardens with Japanese landscaping, a boating lake, tea shop, and an open-air theatre stage (opened to the public in 1929).

# Historic Construction and Materials

## INTRODUCTION

The form and character of buildings – from an intimate lightwell of an early 19th-century shophouse to the soaring column-free interiors of an early 20th-century church – are determined by the construction technology, materials and skills available at a particular point in time, as much as by the visions and desires of their patrons and designers. The long spanning ability of steel beams enabled skyscrapers to supplant the early low-rise office buildings, just as the advent of slender metal-framed windows allowed ample natural daylight to enter the interiors, replacing traditional timber louvres. The historic building fabric is thus a tangible record that speak of the evolution of construction techniques, fine craftsmanship, and embedded industrial processes long lost.

Understanding the provenance of different building elements, such as bricks fired in the kilns of Kallang Basin or cast iron rainwater downpipes imported from Scotland, provide insights into larger geographical histories, commercial activities and economic links that may no longer be in existence, fostering a deeper appreciation of movements of materials and know-how between distant localities.

At the experiential level, an architectural material palette particular to a bygone era brings forth vivid imagery and evokes memories through colours, textures and patterns. An urban ensemble comprising buildings of varying vintage is a rich repository of the material history of Singapore, forming a complex narrative of technology, industry, commerce, culture and social practices in our built environment.

A good understanding of building materials in heritage buildings – their manufacturing processes, function, characteristics and deterioration – is also essential to guide and inform the use of appropriate conservation methods, products as well as new interventions that are compatible. This appreciation goes a long way in avoiding irreversible damage and future maintenance issues, ensuring the continued longevity of our heritage.

## Building Materials Commonly Used in Different Historical Periods

	ROOF	STRUCTURE	WALLS & FINISHES	DOORS & WINDOWS	FLOORS
<b>EARLY–MID 19TH CENTURY</b>	<ul style="list-style-type: none"> <li>• Clay roof tiles</li> <li>• Timber roof trusses</li> </ul>	<ul style="list-style-type: none"> <li>• Brick masonry</li> </ul>	<ul style="list-style-type: none"> <li>• Lime plaster</li> <li>• “Madras chunam”</li> </ul>	<ul style="list-style-type: none"> <li>• Timber frames</li> </ul>	<ul style="list-style-type: none"> <li>• Timber planks</li> <li>• Timber joists</li> </ul>
<b>LATE 19TH–TURN OF 20TH CENTURY</b>	<ul style="list-style-type: none"> <li>• Clay roof tiles</li> <li>• Timber roof trusses</li> <li>• Steel roof trusses</li> <li>• Galvanized iron &amp; zinc sheets</li> </ul>	<ul style="list-style-type: none"> <li>• Brick masonry</li> <li>• Cast-iron columns &amp; frames</li> </ul>	<ul style="list-style-type: none"> <li>• Fairfaced brick</li> <li>• “Blood-and-bandage”</li> <li>• Cast-iron filigree fences, decorative elements</li> </ul>		<ul style="list-style-type: none"> <li>• Steel floor joists</li> <li>• Reinforced concrete floors</li> </ul>
<b>INTERWAR DECADES (1920S–30S)</b>	<ul style="list-style-type: none"> <li>• Steel roof trusses</li> <li>• Asbestos</li> </ul>	<ul style="list-style-type: none"> <li>• Steel frame &amp; concrete composites</li> <li>• Ferro-concrete trusses &amp; parabolic arches</li> </ul>	<ul style="list-style-type: none"> <li>• Plywood</li> <li>• Aluminium</li> <li>• Porcelain Enamel tiling</li> <li>• Shanghai plaster</li> </ul>	<ul style="list-style-type: none"> <li>• Steel-framed windows with plate glass</li> </ul>	<ul style="list-style-type: none"> <li>• Cork</li> <li>• Rubber tiles</li> <li>• Terrazzo tiles</li> </ul>
<b>POST WWII –1960S</b>	<ul style="list-style-type: none"> <li>• Reinforced concrete flat roofs</li> </ul>	<ul style="list-style-type: none"> <li>• Reinforced concrete</li> <li>• Steel frames and trusses</li> <li>• Castellated beams</li> <li>• Prefabricated hollow cement blocks</li> </ul>	<ul style="list-style-type: none"> <li>• Veneer finishes</li> <li>• Concrete ventilation blocks</li> <li>• Brick tiles</li> <li>• Mosaic tiles</li> <li>• Thin stone cladding</li> <li>• Brick masonry</li> </ul>		<ul style="list-style-type: none"> <li>• Reinforced concrete</li> </ul>
<b>POST- INDEPENDENCE</b>		<ul style="list-style-type: none"> <li>• Reinforced concrete</li> </ul>	<ul style="list-style-type: none"> <li>• Pre-cast concrete panels &amp; tiles</li> <li>• Metal cladding</li> <li>• Plastic cladding</li> </ul>	<ul style="list-style-type: none"> <li>• Glass curtain walls</li> </ul>	

*By the mid-1800s, local contractors had acquired the capability to construct ecclesiastical monuments such as the Cathedral of the Good Shepherd, considered one of the largest of its time.*



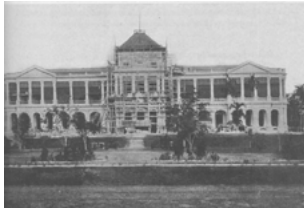
## EARLY TO MID 19TH CENTURY

Depictions of colonial Singapore during the first few decades of its founding show early brick masonry and clay-roofed shophouses and godowns lining the Town's southern coast, and along the banks of the Singapore River. These had swiftly replaced earlier structures in timber and thatch in the vernacular tradition, following the adoption of the first Town Plan of Singapore in 1822, which mandated permanent building materials to be used for protection against fire. These were mainly low-rise two-storey buildings with load-bearing brick façades and party walls that supported timber floor and roof beams. Common floor finishes included terracotta tiling on the ground floor and timber planks above.

The early brickworks were hand-made units using raw materials extracted from good quality clay from the southern and western areas of Singapore. An early clay production area was the Rochore-Kallang River area, where brick kilns were set up as early as the 1820s by immigrants from South India who brought with them knowledge and skill in brick making. These early bricks did not have the same quality in firing and workmanship as those manufactured using industrial production methods introduced after the mid-1800s, a key reason why fairfaced brickwork was then rare.

External and internal walls were finished in lime plaster. Indian plasterers also introduced the use of Madras chunam, mainly for interior walls of prominent civic buildings such as the first St. Andrew's Church. This was a traditional self-finishing render using indigeneous materials such as egg white, shell lime and jaggery mixed with water in which coconut husks had been soaked, which was polished with rock crystal upon setting, giving rise to a refined, satiny smooth finish.

Beyond the municipal limits, however, plantation bungalows and early military barracks continued to be built mainly in timber, some supported on brick piers to raise the ground floor above the flood line.



*The Government House (Istana) - an early large building constructed by convict labourers.*

## LATE 19TH TO TURN OF THE 20TH CENTURY

The year 1876 marked a significant shift in Singapore's urban and architectural development when the territory became the headquarters of the new Crown Colony of the Straits Settlements. Its newfound strategic and economic importance spurred rapid growth, with new offices, banking halls, government buildings and places of worship built to serve the needs of the burgeoning town. Many of these – such as the St. Andrew's Cathedral, Government House (present-day Istana) and Raffles Museum (present-day National Museum of Singapore) – were continued to be constructed of bricks manufactured using industrial methods in government-owned factories, built by Indian convict labour under the watchful eyes of early colonial engineers such as McNair.

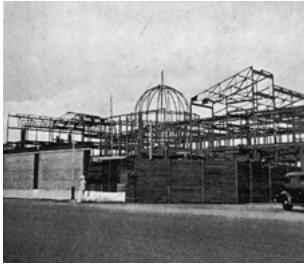


*Cast iron columns supporting the choir loft at the Cathedral of Good Shepherd*

Business boomed for the agency houses with the rising demand for European construction materials and skills. Steel floor joists and roof trusses were introduced by the 1890s for their ability to span larger spaces, while galvanized iron and zinc roofing adorned mansard roofs and cupolas. Cast-iron filigree decorative elements and fences that appeared from the 1860s onwards culminated in the erection of the third Telok Ayer Market in 1890 – one of the earliest structures in Asia made entirely of cast iron from the foundries of Walter Macfarlane & Co., Glasgow.

Elsewhere, there was a use of innovative hybrid construction technology such as lightweight reinforced concrete flooring supported on corrugated steel arches of the 1904 Victoria Memorial Hall, designed in engineering offices in London. This reflected the wealth of the colony as well as emergence of a vigorous construction industry. Chinese contractors such as Lim Loh and Wong Ah Fook brought with them expertise in building large edifices with eclectic designs promulgated by expatriate British architects trained in the beaux-arts tradition, such as the Teutonia Club (now Goodwood Park Hotel). The confidence and fine artisanship of brickmasons could be seen in handsome fairfaced brick buildings such as St. George's Church at Tanglin Barracks, as well as the Edwardian 'blood-and-bandage' idiom of the Central Fire Station, both featuring imported industrial bricks. At the turn of the 20th century, the cosmopolitan complexion of Singapore could be discerned in its townscape. It heralded the critical transition between traditional and industrial building materials and technology, and the advent of the Modern Age.





*The Supreme Court under construction using steel frame.*

## INTERWAR DECADES (1920S–30S)

By the interwar decades, Singapore had become a vibrant and prosperous cosmopolitan city, as the main global distribution centre for Malayan tin and rubber. The sustained rise in Singapore's fortunes and strategic significance gave impetus to a more concerted programme of high profile public works projects in a bid to cement its status as 'the beacon of British Malaya'.

Marking the centennial of Singapore's founding, the early decades of the 20th century was a transitional phase in the island's architectural development, between the conservative "Stripped Classicism" and early Modernism such as art deco and Streamline Moderne. Completed barely two years apart, the Kallang Airport projected an image of lightness with its streamlined building silhouette and flat roofs with crisp, thin edges, whereas the neo-classical facades of the Supreme Court emphasized gravity, antiquity and balance. Beneath their dissimilar appearance however, both buildings employed a modern steel frame structure and concrete slab composite construction system, favoured for its ease and speed in construction.

More fundamentally, the transformation was not just an aesthetic-stylistic one, but in manufacturing processes in the building construction industry and trades. Traditional building materials were manipulated and transformed in completely new ways – timber reappeared as plywood; the manufacture process of glass was transformed; new metallic alloys were created.



*The proliferation of Shanghai plaster defined the monumental character of Singapore's city skyline in the interwar years, seen in the seafront promenade of mercantile and institutional buildings along Collyer Quay (Union Building, Clifford Pier, General Post Office) – across the Padang (Municipal Building and Supreme Court), to the eastern coastline of Singapore (the SSVF Drill Hall).*

Steel-framed window of the former Ford Factory, with hand-finished non-actinic plate glass in various tints of green to reduce the equatorial glare and to provide privacy. With their slender frames, such windows afforded large glazed surfaces for daylighting interior spaces within large buildings at a time when electric lighting was not readily available.



Brossard Mopin, a French engineering and construction firm and pioneer of ferro-concrete construction in Europe, brought in cutting-edge technology in buildings such as the Singapore Railway Terminus passenger hall.





Advertisements of new building materials – Cressonite rubber tiles that were used in many 1930s public buildings, including the former Supreme Court.



Pre-cast ornaments in the form of reed bunches adorn the Capitol Building.

A plethora of unusual architectural finishes were introduced for the first time in Singapore – such as porcelain enamel tiling, aluminium handrails, steel windows and cork flooring. Besides exotic imports, local innovations such as rubber tiles and terrazzo tiles were widely used. In turn, these changes profoundly influenced the way architectural forms and spaces were experienced.

Besides steel, reinforced concrete construction was introduced during the interwar decades and became popular for its structural economy and fireproof properties compared to load bearing brick construction. The concrete trusses of Clifford Pier and the parabolic arches of the Straits Settlements Volunteer Corps Drill Hall flaunted the innovative structural designs that enabled their soaring column-free interior spaces. At the Capitol Theatre, the builders experimented with prefabricated ornamental elements on a grand scale, capitalizing on the economy of scale afforded by repetitive design elements.

The advent of Shanghai plaster during the interwar years marked another significant progress in local building craftsmanship. A prestigious material that conveyed a sense of gravitas, this was an architectural finish of stone chipping aggregates bound by a cement binder, with a naturalistic stone-like texture. Unlike traditional lime plaster and stucco work, Shanghai plaster had the flexibility for both on site hand-rendering and off-site pre-cast production. Moreover, as a self-finished material, it is more durable and resistant to weathering.

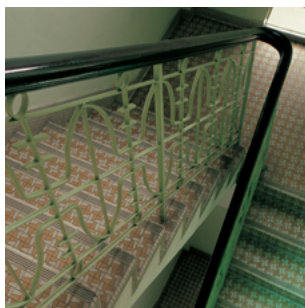
## POST WWII TO 1960S

The post-World War II decades was a period of great political change as the process of decolonization began, accompanied by social welfare reforms. The colonial government embarked on a concerted series of development programmes. The construction of modern working-class homes by the Singapore Improvement Trust (SIT) was accelerated, while a great number of new English-stream government schools were realized by the Public Works Department (PWD).

With austere economic conditions, the ornamental historical revivalist styles prevalent during the prewar years became untenable in terms of cost, efficiency and propriety. Government architects and engineers adopted a no-frills approach in the new 'architecture of economy'.



*From top: precast vent block screen and exposed aggregate panelling at Old Kallang Airport Estate embody the 'architecture of economy' approach to design in resource-scarce postwar Singapore. Building materials were used in experimental and innovative ways that did not compromise on aesthetics.*



*Mosaic tiling in attractive patterns enlivens utilitarian, everyday spaces such as this staircore in Nanyang Pho Leng Huay Kuan (1953).*

Reinforced concrete was rapidly adopted as the de facto construction technology. Ease of replication was an important factor in the design of state-funded building programmes, capitalizing on economies of scale. 'Standard' plans in public housing employed regularly spaced structural grids that significantly reduced material and labour costs. The maturation of reinforced-concrete design and growing sophistication in its detailing resulted in a refined aesthetic that emphasized the prismatic quality, smooth planarity and crisp silhouette of these cubic volumes.

The explosive increase in building activity and diversification of building types in the post-war decades also included large-volume spaces such as sports halls, auditoria and factories. The steel frame became an economical means to create column-free interiors that offered maximum flexibility to users. Innovations such as the steel truss and castellated beams provided affordable alternatives to deep concrete beams with substantial savings in material cost.

Another material that could meet the demands of stringent construction budgets was the humble brick, which emerged from dormancy in the preceding decades. Its affordability, durability, ease of maintenance and attractiveness made it an ideal material for state-financed infrastructure and building projects. An example is the Pasir Panjang Power Station, whose expression of raw industrial power is given by its brick 'skin'. In public housing projects, the modularity and attractive warm colour of brickwork impart a sense of comfort and human scale to the repetitious mass housing blocks and their predominantly plain plastered surfaces. For its aesthetic qualities, fairfaced brick was also favoured in prominent civic buildings such as the National Library at Stamford Road, and later the National Theatre. The burgeoning demand for this material fuelled the rapid growth of the local brick-making industry, with Alexandra, Jurong and Nanyang Brickworks becoming household names.

Alternative construction methods, such as prefabrication, and new affordable building materials, like hollow cement blocks and veneer finishes such as brick tiling, mosaic and thin stone cladding marked a period of experimentation and innovation. In particular, mosaic tiling was exploited by modernist architects who abhorred overt ornamentation. As an architectural finish, this possessed an innate ability to enhance human scale and provide visual relief. The kaleidoscopic permutations – random mix, checkerboard, bands and geometric shapes – greatly enlivened the interiors of numerous modern buildings.

Singapore architects in the 1950s and early 1960s searched for a unique



A trio exhibiting 'Malayan' architectural character, from left: Church of St. Bernardette (1959), National Theatre (1963), and the Singapore Conference Hall and Trades Union House (1965).

'Malayan architecture' that would express modernity and progress while reconnecting with the local climate, craft, materials and cultural symbols. A central concern was modifying modern architecture to respond to the local climate. An expressive architectural vocabulary, featuring porous building envelopes with wide-ranging designs of sunbreakers and ventilation blocks, drew lessons from indigenous buildings, allowing architects to connect with Malayan culture.

Advancements in prefabrication technology and material engineering enabled their popularization as a complementary system of climate control. Comprising individual units that were plant-manufactured and assembled on-site, these sunshading screens could be custom-designed for new buildings or mounted over existing façades. The wide-ranging design motifs and varying dimensions and materials of these elements became widely popular for their versatility and attractive appearance, serving as useful ornaments that enlivened functionalist modern buildings.

*By the late 1970s, the new OCBC Bank building designed by I.M. Pei, towering over derelict godowns along Boat Quay, heralded the dawn of a new era in Singapore's built environment.*



*The distinctive stepped profile of the Golden Mile Complex (1973) is a symbol of daring urban vision, innovative architectural concepts and cutting-edge engineering know-how of the times.*

## POST-INDEPENDENCE

After Singapore became independent, the 1960s and 1970s saw other changes in architectural production. Most obviously, as urban renewal gained pace, buildings grew in scale and complexity as skyscrapers and mixed-use megastructures became commonplace. This created opportunities for architects and planners to shape new urban forms and spaces. The new post-colonial generation of local planners and architects gave special consideration to public welfare, as seen in the provision of generous public spaces and amenities. In doing so, they exploited the capacity of reinforced concrete to create vast new spaces at low cost. The proliferation of HDB New Towns in quick succession spurred the growth of homegrown industries and manufacturers such as National Iron & Steel Mills and Lea Hin, which supplied reinforcement steel and metal windows for tens of thousands of public housing flats.

Many new monumental-scale private projects and public facilities, such as Golden Mile Complex, were designed using prefabricated building components and finishes, like pre-cast concrete panels and tiles. These were new products that were available as a result of the modernization of the local construction industry and building products trade, with the influx of large-scale contracting firms with specialized know-how from the West and Japan. Singapore was quick to adopt new building technologies, like glass curtain walls and even metal and plastic cladding.



**2 |  
PLANNING WORKS FOR YOUR  
HERITAGE BUILDING**



## HERITAGE BUILDING OWNER AS THE CUSTODIAN OF HISTORY

All property owners have a duty of care to ensure that their buildings are safe for their occupants, and that any addition and alteration works are in line with planning and building regulations of the day.

In addition to the function of being shelters, heritage buildings are also architectural heirlooms, passed down through generations. A heritage building owner is the custodian of this precious piece of history, responsible for the safeguarding of its structural, material and heritage integrity for the coming generations.

Most of the time, heritage buildings are made of materials unlike current-day construction, using different methods and technology, giving rise to different building properties and performance. For example, 19th-century hand-made bricks may be underfired, paler in tone, softer, more breathable, and smaller in dimensions than mass machine-made modern bricks.

Any renovation and maintenance works should cater for the specific historic building properties, using appropriate materials and methods. Conventional building maintenance practices not customized to heritage buildings may worsen or even cause deterioration. A common mistake is the application of non-breathable synthetic paint, causing moisture to be trapped within the historic lime plaster and brick underneath. Where the building's historic features, materials and construction are not well-understood, it may be necessary to undertake a conservation and dilapidation study.

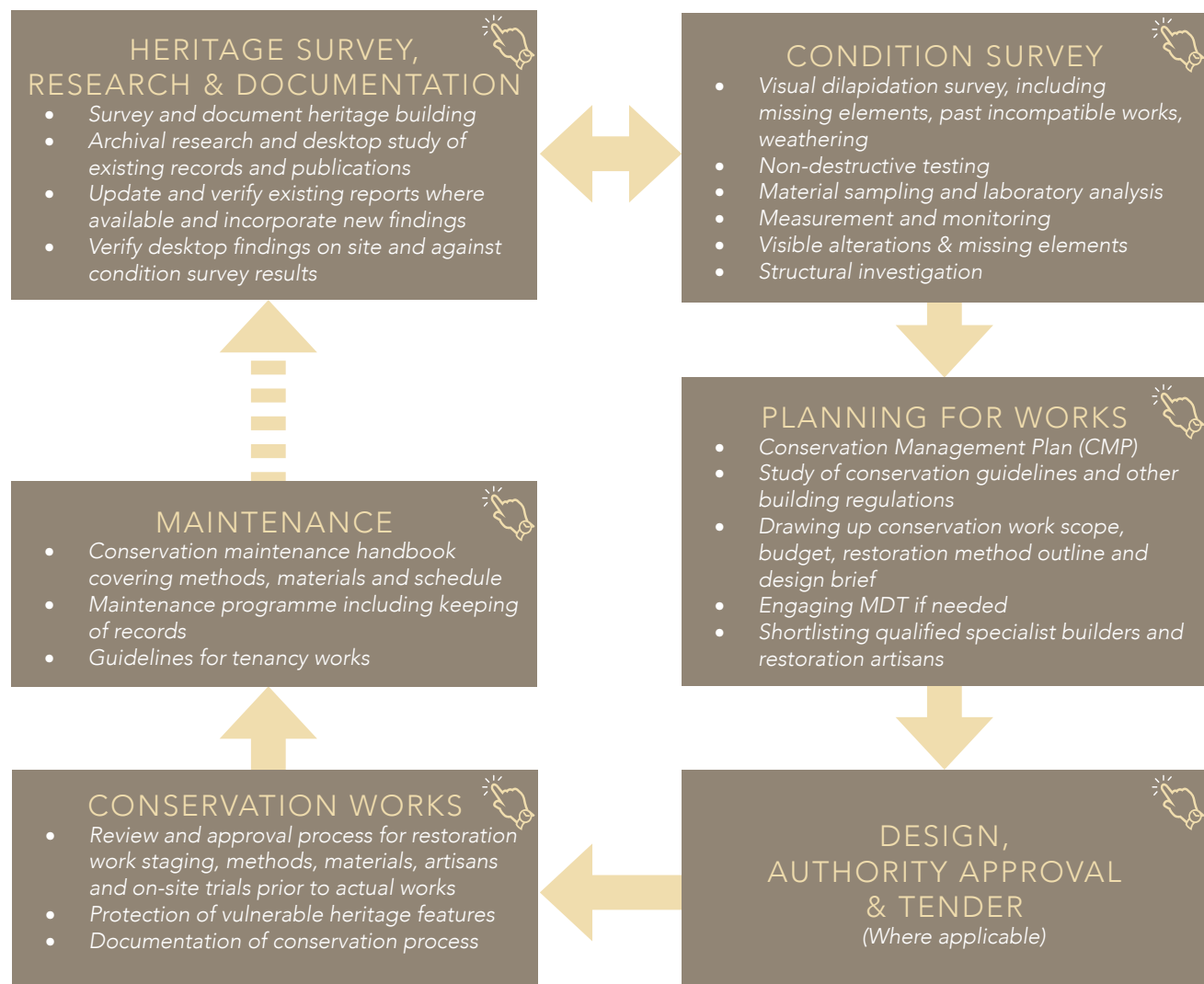
It is important to appreciate the building in all its historic characteristics and peculiarities, even when it may not conform to current conventions of beauty and function. Its design, features and construction were conceived and created in a particular moment in history and embody the culture, commerce, craftsmanship, innovation and values of a past era.

It is crucial to recognize that the heritage building, and the history embedded in its bricks and mortar, are an integral, meaningful part of the historic neighbourhood, the city and its public space, the society and its history. In a way, the building owner, together with any person responsible for its care including builders, consultants, estate managers and maintenance team, are collectively the custodian of heritage that belongs symbolically to everyone.



## Conservation Process | Overview

Neglected and unoccupied heritage buildings are prone to accelerated decay, so it is important to put it to appropriate use, carry out regular maintenance and inspection, and undertake conservation works when necessary. Such works may vary in scale and scope, ranging from minor repairs, restoration of specific heritage features, to a full scale conservation project that calls for engaging a multi-disciplinary consultant team (MDT) and authority submissions. Regardless of the scale and scope, all works should be premised upon Heritage and Condition Survey findings, and preceded by comprehensive documentation.



## Drawing Up the Scope | Factors for Consideration

How do you decide what course of action is needed? To summarise, you should first consider its heritage value – be it historical, cultural or architectural merits. Next, investigate the physical condition and intactness of your building. Finally, identify your new needs and study their possible impact – and develop a conservation strategy.

For works involving substantive intervention such as adaptive reuse projects, it is recommended to engage a conservation consultant to draw up a Conservation Management Plan (CMP). This will establish the heritage significance and conservation priorities, along with recommendations of how this will be sustained through the intended changes (new use, alteration, repair or new management), proposed mitigations for any potential impact, and long term maintenance. The CMP will help all parties involved in the project gain a deeper understanding of the heritage site, provide guiding principles, and facilitate informed decision-making.

### CHARACTER OF BUILDING

The character of your building will set the context for any conservation or restoration work you decide to undertake. Is your building a shophouse in a row of identical terraces? In that case, the character of your building lies not only in its physical structure, but in its relationship with its neighbours. By contrast, if you are tasked with restoring a national monument, its character may derive from its uniqueness. Understanding the character of your building before starting any conservation and restoration work will help safeguard that character.



Do you remember what kind of building you own? Find out in [Chapter 1](#).

### CONDITION OF BUILDING

The condition of your building will establish the extent of work needed. If your building has been well maintained and in continued use, only minor works will be necessary – perhaps a coat of paint, or replacing some damaged plasterwork. If, however, you are planning to restore a severely dilapidated building, the road ahead will be much longer.



Refer to [Chapter 4](#) for guidelines on finding out the condition of your building.



Find out what kind of *professional advice* is available to you as a heritage building owner.

It is crucial to get professional advice when assessing the condition of your heritage building. While cosmetic issues may be visible from the street, structural problems may be harder for the untrained eye to identify. Once you have evaluated the condition of your heritage building, you'll have a better idea of how big your project will be.

### AVAILABILITY OF RESOURCES

The availability of resources will determine what you can and cannot do. There are two major points to consider here: your budget, and the availability of materials plus skilled workers. Certain historic building materials can be expensive, and replacing certain building elements may be a costly affair. An architect or quantity surveyor experienced in heritage conservation can advise you about how much the planned works will cost.



If a full-scale restoration is beyond your budget, consider breaking your restoration project up into phases. Prioritize work according to what is most urgent, and what you can afford to do within your financial means. Replacing a leaky roof will be a more urgent priority than reinstating a modified historic facade, for example.



Sometimes, it may be impossible to find an exact replacement for damaged or missing historic building materials. Rare woods, ivory from endangered animals, and coloured marble from exhausted quarries can present challenges. It is important to discuss your options with heritage professionals. You may want to source similar-looking materials, but you could also consider contrasting modern replacements with the original built fabric.

Finally, it may be hard to find workers with the right traditional building skills. Many of Singapore's historic buildings were built by migrant artisans and builders from China, India and beyond. Will you be able to find workers able to recreate cut-and-paste porcelain work, or a contractor who knows how to work with lime plaster? By identifying the character of your building and the extent of works needed, you'll be able to figure out what sort of materials, labour and finances are necessary before embarking on any restoration work.

*Some restoration works to historic elements, such as stained glass and ornamental plasterwork, will require the skills of specialized artisans.*

## Conservation Intervention Works

Before you get started with work on your historic building, it is important to appreciate its heritage value or assets, identify what your priorities are, how much work needs to be done, and how to go about it. Naturally, the course of action and the degree of intervention will vary according to the circumstances of each individual building.

Does your building show signs of wear and tear, and how extensive are these? Does the building only need a new coat of paint, or is more substantial structural work required? Are there lost building elements that need to be reinstated? Do you intend to construct a new extension? It is important that informed decisions are made, based on a comprehensive understanding of different considerations and priorities.

Introducing new amenities into a historic structure while not destroying its heritage character is a fine balancing act. Buildings that have become dilapidated will require the most substantial – and costly – work. By starting with small, daily maintenance, you can prevent minor problems from escalating into serious headaches.



Refer to '*Heritage and the Law in Singapore*' for notes on requirements by law on heritage buildings in Singapore.

Before commencing on any intervention, it is necessary to assess the impact of the work on your building – especially those elements that contribute to its heritage value – and whether these will be adversely affected. This will help establish the extent of work you should undertake. It is also a good idea to consult the various publications and guidelines put out by the URA or NHB. This will help you get a sense of what you can and cannot do with your heritage building.

This chapter presents different types and extent of conservation work, and when these are necessary and appropriate to be carried out.



Birds' droppings may look harmless but are actually acidic in nature, causing erosion and damage to the paint and plasterwork. Such damage can be avoided with regular maintenance.



## 1 - DAY-TO-DAY CARE

This is your first line of defence against deterioration. Buildings that are in use generally experience wear and tear on a daily basis. The weather, pollution, improper maintenance and so on can all damage a building. Focused and attentive care can, however, help prevent further deterioration and save both time and money in the long run.

If you own a heritage building, do acquaint yourself with proper maintenance methods and materials for your property. Keep your building clean and make sure surfaces are finished properly to ensure they are protected from the elements. If you are renting out your heritage property, let your tenants know how the place should be maintained. Diligent daily care proves the old adage that prevention is better than cure.



Leakage in the roof can lead to a host of other issues, such as termite attacks on timber roof structures. To prevent such issues, the roof should be regularly checked for leaks and cracks.



## 2 - SCHEDULED MAINTENANCE


Scheduled building maintenance is the next step in looking after your heritage property. It is a good idea to draw up a schedule for maintenance work. This can include oiling door and window hardware, clearing drains and gutters, and having wiring and plumbing checked. You can keep your property looking fresh by repainting exterior walls every few years – just make sure the type of paint you use is appropriate for your building and its materials.

A good way to approach scheduled maintenance is to identify what work needs to be done at various intervals. Decide what should be done on a monthly, quarterly and annual basis and so on, and adhere to that schedule.

You should also be aware of the various building materials used in your property, the specific care they need, and their normal lifespans. For example, wooden elements should be inspected regularly and treated carefully to prevent rot, water damage or attacks by pests such as termites. With the right care, these elements can last for a long time.




Refer to 'Developing a Maintenance Plan' to find out how often you need to maintain your building.

 Use the sample *investigation checklist* at the back of this volume to help you take notes on your building's condition.



Rather than expedient replacement, damaged timber louvred windows can be repaired by splicing the rotted sections.

 Recall - Due to *different trends, available technology, materials and skills of each period*, historic buildings from differing periods may vary in their material use.

 What's the difference between 'restore', 'repair', 'reinstatement' and 'reconstruct'? Find out in the *glossary*.



### 3 - REPAIRS

Even with the best maintenance regime, buildings suffer damage over time. Doors warp and come off their hinges. Window panes crack. Storms dislodge roof tiles, causing leaks. Rising damp is another common problem in heritage buildings – the result of ground moisture being drawn up into the building's walls and floors.

Again, inspecting your building regularly will help you spot problems early on. If you can afford to, address issues as soon as they crop up. But do not rush repairs; careful planning of repair work can help smoothen work processes on-site. If your roof is leaking, for example, fix that first to ensure that your building is watertight, before replacing water-damaged floorboards.

It is worth setting aside some budget for repairs to historic properties. Damage to buildings can happen unexpectedly, so having the funds set aside will afford you some peace of mind.



### 4 - CONSERVATION AND RESTORATION

In very simple terms, conservation is about retaining historic buildings and protecting their integrity and significance, while restoration aims to bring damaged buildings back to their former glory.

Heritage **conservation** is not about stopping the clock, but managing the inevitable changes that buildings experience - in a way that their historical and cultural significance are not lost in the process. It is necessary to understand the building's heritage value, informed by rigorous research on its historical, architectural and material aspects. Conservation is an active, rather than passive process, and the best conservation efforts look towards the buildings' future. One way to start this process is to prepare a Conservation Management Plan, which will help you plan the building's ongoing upkeep and future maintenance needs. **Restoration** is a broad term which refers to the **repair, reinstatement** – sometimes even **reconstruction** – of historic buildings to recover key attributes that have been obscured or destroyed. Historically, 'restoration' also referred to an extensive, and at times destructive, process. Many 19th century 'restoration' works were in fact fanciful reconstruction of buildings that drew more on the imagination of architects rather than historical evidence.

Over the course of the 20th century, approaches to restoration have changed substantially. The principle of ‘maximum retention, minimum intervention’ is the dominant philosophical approach in many countries, including Singapore. A good restoration project returns a dilapidated historic property to functionality through careful repair or sensitive alteration, while celebrating its heritage features, value and character.



*Adding a secondary glazed door or window behind the historic leaf is a commonly used design enhancement strategy for adapting an old building to modern-day requirements.*



## 5 - DESIGN ENHANCEMENT

Design enhancement refers to improving the performance of a historic building element that has been shown to be defective – including those that are not structurally sound, or that consistently fail to hold up to weather conditions. It can also refer to adapting historic elements to present-day requirements, for example by double-glazing windows for acoustic and thermal insulation.



## 6 - REBUILDING, REINSTATEMENT, REPLICATION

Sometimes it is necessary to replace elements of a building. In extreme cases – such as in the event of a fire or other natural disaster – entire buildings may need to be reconstructed.



*Due to differing manufacturing technologies of the past and present, some historic features, especially those that were traditionally hand-shaped or custom-made, may not be replicable today.*

A building’s original architectural features can be lost over time through damage, neglect or wilful destruction. Over the course of the 20th century, many old shophouses had ornamental mouldings scraped off, and had their wooden shutters replaced with ‘modern’ aluminium framed windows. In such cases, it is often desirable to reinstate these original features; this will improve their legibility as historic buildings and restore harmony to the streetscape.

When replicating architectural elements, the following questions should be considered: Should replacement features be distinguishable from the original? Should the same materials and colours be used in replicated elements? To what extent should lost materials be replicated and reinstated? While it may be possible to recreate the look of historic elements, the original physical fabric of a building carries historic information that is impossible to replicate, such as the method of construction, or the use of certain materials that are no longer available. Consider whether reinstatement is desirable at all.

On the other hand, the loss of architectural elements and modification of a building may be a compelling part of its history. A shophouse which was stripped of its ornamental mouldings in the 1930s and renovated in an art deco style may be better left as it is; reverting the façade to its original design would rob the building of its history and character.

There is no 'one-size-fits-all' approach, and the specific history and urban context of your building will determine whether replication and reinstatement is appropriate.

Rebuilding should only be considered in the most extreme cases, such as when structural failure or mitigating circumstances rule out other viable options. When reconstructing a historic building, it is very important to consider issues of authenticity: why are you rebuilding this historic building (or part of it), and will the result be a faithful revival or a false piece of history?



Originally a school, the former St. Joseph's Institution building on Bras Basah Road has been adapted for reuse as the Singapore Art Museum.



## 7 - ADAPTIVE REUSE

Adaptive reuse refers to the deployment of an old site or building for a purpose other than that which it was built for.

The modifications are made necessary by the change in use. The original functions of historic structures may cease over time. This can happen for a number of reasons. Sometimes the building no longer meets the needs of a community. In other instances, the very function of the building is rendered obsolete - such as opium houses.

A good adaptive reuse project begins with identifying an appropriate new use and programme brief that sits well with the building's history, architectural character, scale and interior layout. This would minimize intervention in the original fabric of the building and ensure optimal retention of its heritage value. A disused church might make a good community centre but may be less appropriate as a nightclub or a youth hostel. The open spaces of a former warehouse might readily make for an open-plan office but may require more intervention to transform it into a school, which would require subdivision to create cellular learning spaces and classrooms. It is also important to note that the URA has rules governing allowable uses of conserved buildings, as set out in the Master Plan for the zoning area a heritage building is in.

A useful document to read is URA's 'Making "Additions and Alterations" to Conserved Buildings'. Read it [here](#).







*New additions introduced through sensitive conservation design intervention: (from left) National Museum of Singapore, 14 Cable Road, The Sandalwood at Temberling Road.*



## 8 - INCORPORATING NEW BUILDINGS

Over time, you may find your spatial needs are no longer served by your heritage building. It may then be desirable to extend the building, or even create a complex of buildings by incorporating new buildings next to the original structure.

When designing new extensions to heritage properties, a number of things should be considered: how will the design of the new building respond to the historic structures? Will the new building draw on the design of the heritage building or create a visual contrast? How can damage to the original historic buildings be minimized?

In general, it is considered good practice to distinguish any new work from the original building, allowing those who use the space to 'read' the way the building has grown over time, such that the new becomes another chapter in the history of your heritage building.

## Developing a Maintenance Plan

It is tempting to assume that all problems in a historic building will be resolved once it has undergone restoration or repair works. In reality, however, a building will undergo natural wear and tear as it is being used. Although your heritage building has indeed stood the test of time, its materials are still vulnerable to deterioration, especially if it is neglected or inadequately taken care of. With this in mind, it is important to maintain your building by carrying out routine works to keep decay at bay.

There are several types of maintenance that you should plan for:

**Housekeeping:** Regular Washing / Cleaning

**Preventative Maintenance:** Routine work to prevent problems, such as cleaning gutters, repainting works or repairs covered under warranty of particular building parts

**Repair/ Replacement:** Repair of damaged elements



Use the exercise *Noting Down Physical Characteristics of your Heritage Building* in Chapter 1 to help you identify your building's key features.



Use the sample *Inspection Checklist* to find out your building's condition.



Use the sample *Maintenance Log Book* as a reference.

For historic buildings, routine preventative maintenance is always encouraged. Bear in mind that repairing or replacing historic materials can be costly and often difficult to carry out, since the historic materials are no longer in production, leading to the use of even more costly specialist materials to repair your building.

Before starting to develop your maintenance plan, do take note of the following -

- Understand what are the features of your building, especially those that have high heritage significance, or require special care
- Assess the condition of your building to understand its needs
- Identify which elements you can inspect yourself, and which elements need contractors to carry out the works
- Identify which elements are covered under warranty, and when they are due for warrantied maintenance
- Develop a timetable and a log book to record all maintenance that you have carried out.



## HOW OFTEN DO I MAINTAIN?

The following list, although not exhaustive, gives a rough indication of how often you should take care of different parts of your building. Generally, building elements exposed to the weather, especially those used for drainage, will need more attention, since any moisture leaking can lead to deterioration in the building.

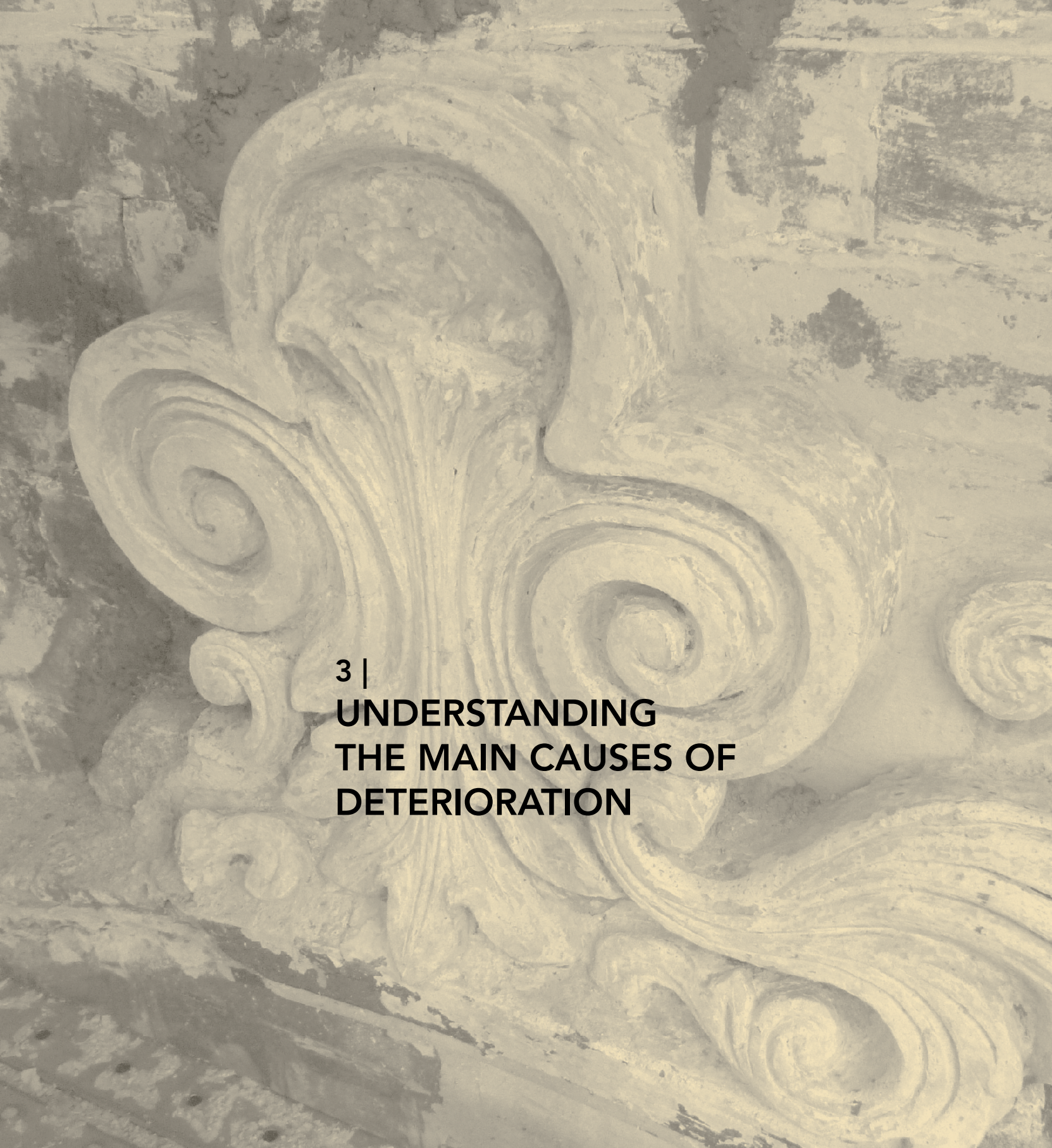
Element	Preventative Measures			Repair/ Coating Replacement*		
	Monthly	Quarterly	Yearly	Half- Yearly	Yearly	Every 5 years
Roof Coverings			✓		✓	
Gutters & Flashing		✓		✓		
Rainwater Downpipes		✓		✓		
Exposed Masonry Walls			✓			✓
Stone/ Shanghai Plaster/ Unpainted Concrete Walls			✓			✓
Interior Walls	✓				✓	
Doors & Windows	✓				✓	
Timber Flooring/ Stairs	✓			✓		
Tiled/ RC Flooring	✓					✓



\*Schedule a check for damages and repair or replace accordingly, if found. You may use the *Inspection Checklist* to guide you along.

As a building owner, it is a good idea to keep a log book for your building to record down when you last did a maintenance check, what you found, what was done, or even whether a contractor was engaged to carry out the works. The *sample* in the resources section, organized according to works needed for each scheduled review, is a rough guide to how you can organize the log book, although you should feel free to customize it to the characteristics and needs of your building.

PART II  
**CARING FOR AN  
AGEING BUILDING**

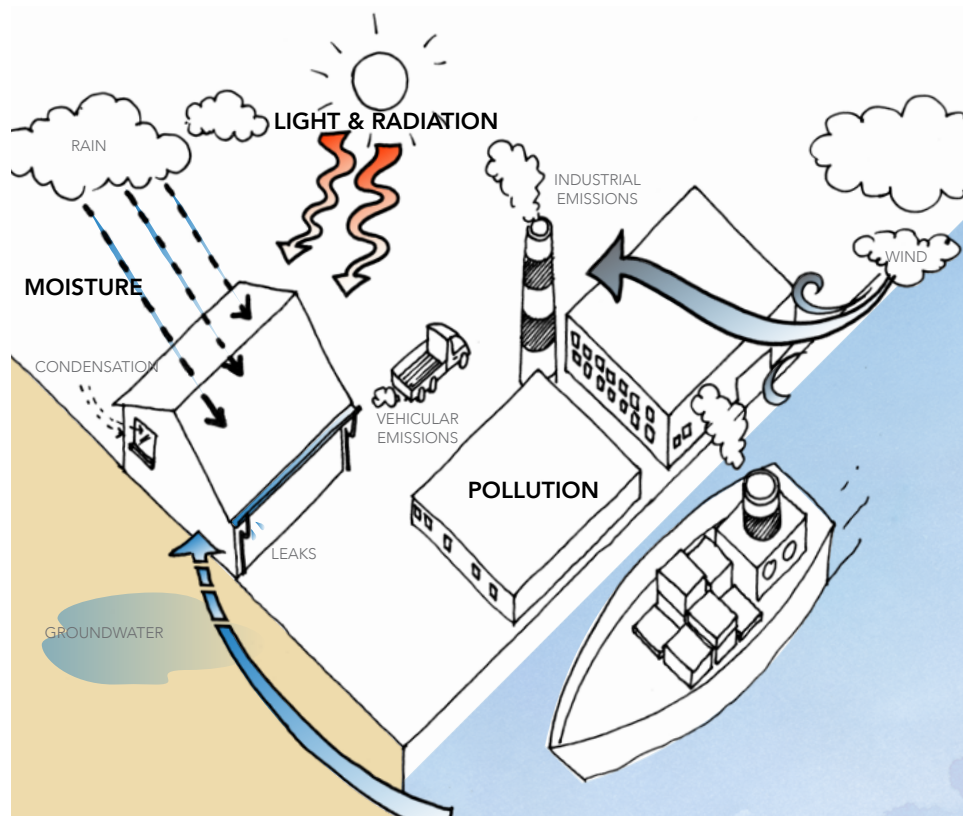


**3 |  
UNDERSTANDING  
THE MAIN CAUSES OF  
DETERIORATION**

## Environmental Factors

Like any other infrastructure and buildings, heritage buildings are exposed to a host of environmental elements that can lead to various states and degrees of deterioration. The types of materials used and construction techniques of heritage buildings can differ from new buildings today. Many, however, have successfully withstood the test of time whilst others are in various states of deterioration. Changes in their use and exposure condition, both internal and external environments, could also accelerate their rate of deterioration.

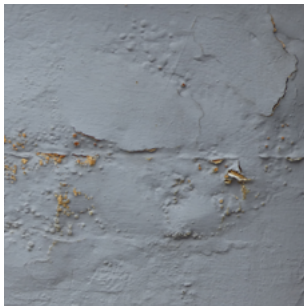
The common elements of the environment that affect the health and lifespan of historic buildings include moisture, solar radiation, temperature, pollution, chemicals, wind, etc., as illustrated in the figure below:



*Environmental sources of elements that can aggravate the rate of deterioration in a historic building.*



*Moisture-induced damage often occurs at joints and cracks on external wall finishes, bridging at insulated walls, open joints, penetrations through walls, roof and basement, rainwater collection points, and windows.*



*Application of impervious surface finishes such as cement-based render and film-forming paint systems can worsen the situation by trapping moisture within the wall. In the image above, trapped moisture under the paint resulted in a bubbling appearance, peeling, and cracks on the surface of the wall.*

## EFFECTS OF MOISTURE

The presence of moisture can aggravate decay of historic building materials, although this manifests in different symptoms from material to material. Some common symptoms include:

- **Timber:** wet rot (fungi growth), termite infestation
- **Brick and Stone:** erosion, salt crystallization damage, swelling
- **Concrete:** corrosion of steel reinforcement
- **Plaster:** Leaching, salt crystallization damage, erosion
- **Metal:** corrosion
- **Paint:** Peeling and blistering, staining, biological growth

## EFFECTS OF LIGHT AND RADIATION

Different wavelengths of light and electromagnetic waves can affect materials to differing degrees, depending on the duration of exposure and sensitivity of the materials. For example, ultraviolet radiation oxidizes and breaks down fibrous products, such as fabrics, paints and dyes. Infrared radiation, produced by artificial lighting and sunlight, has an indirect effect on materials by influencing the moisture content around the surfaces of buildings. Radiation affects the elasticity and strength of materials, causing symptoms such as expansion and cracking. These changes in properties within and around the material have an effect on both the physical appearance and performance of materials.

Solar radiation is accompanied by heat, which causes thermal expansion of materials (resulting in cracking). As a rule of thumb, for every 10°C increase in temperature, the rate of material degradation doubles.

## EFFECTS OF POLLUTION

Pollution is typically emitted by vehicles or industrial activities, especially given Singapore's urban environment. These pollutants create problems at a local scale, but they are also transported in the air over long distances, especially airborne pollutants such as sulphur dioxide, nitrous oxides, particulate matter and lead.

The table on the following page describes the effects of typical pollutants found in Singapore.



Radiation and exposure to rain results in fading of painted surfaces.



Streaking and discolouration resulting from exposure to rain and pollution.

Type of Pollutant	Source	Typical Damage
Carbon dioxide	Industrial & vehicular emissions	<ul style="list-style-type: none"> <li>Carbonation of concrete, resulting in chemical breakdown of concrete and changes to its strength</li> <li>Damage to exterior finishes due to formation of 'acid rain'</li> </ul>
Sulfur dioxide, hydrogen peroxide, hydrogen sulfide, nitrogen oxide		<ul style="list-style-type: none"> <li>Tarnishing of metals</li> <li>Paint damage</li> <li>Defibration (reduction in fibres) of timber surface</li> <li>Damage to exterior finishes due to formation of 'acid rain'</li> </ul>
Particulates & carbon soot		<ul style="list-style-type: none"> <li>Staining/dirt streaking on building surface</li> <li>Mould or algae growth due to accumulation on surface which can aggravate moisture retention in the building</li> </ul>
Chlorides (in areas along the coastline)	Sea air	<ul style="list-style-type: none"> <li>Weathering of masonry wall surface</li> <li>Corrosion of Iron/steel</li> </ul>



### HOW DOES CLIMATE CHANGE WORSEN DETERIORATION?

Globally, the threat of climate change includes floods, extreme weather conditions such as strong winds, heavy rainfall, drought and heat waves, etc. In Singapore, climate change has resulted in short bouts of very intensive rainfall and strong winds. This puts a strain on the gutter and rainwater downpipe, leading to overflow and ingress into the building. Increases in temperature can also increase the rate of chemical reaction and degradation.

Strong winds and rainfall wear out surfaces and delicate architectural features through abrasive wear, causing increasing and unpredictable stress loading on structural members. They also have adverse effects on aged timber and masonry structures which may be poorly protected. Very strong rainfall may have a structural effect on weakened and aged structures.



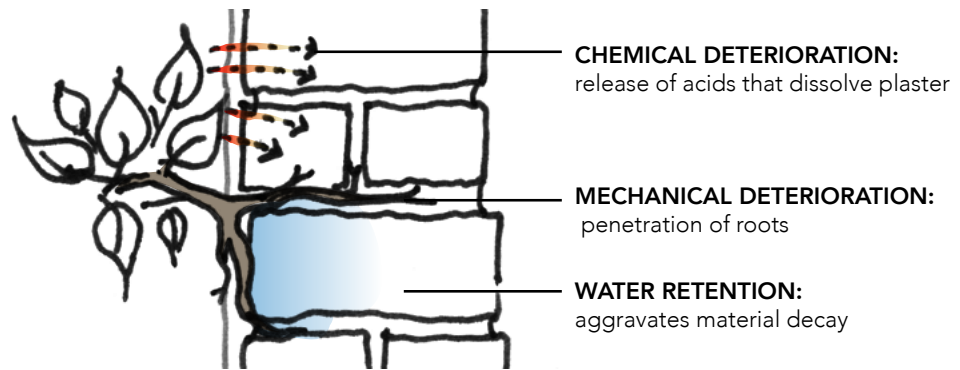


*Biological growth tends to occur at junctions that are constantly exposed to rainfall, and can be a good way to understand the environment of your building.*

## Biological Factors

In our tropical climate, buildings are exposed to abundant rainfall that is conducive for biological growth, especially when water is trapped within the building fabric for prolonged periods. This is why plant growth on the building surface is a useful indicator of excess moisture retention. In addition to the detrimental effects of moisture, such growth of vegetation and fungi/algae can also cause chemical and mechanical deterioration of the building fabric, as shown in the diagram below:

### CHEMICAL DETERIORATION



In the process of respiration, most plants and algae will release acids as a byproduct of oxidation in plant cells. These mild acids are able to gradually dissolve alkaline minerals, such as lime-based plaster layers.

### MECHANICAL DETERIORATION

Once the plaster is softened by the acids, plant roots are able to penetrate through the plaster, even into the walls behind. As the plant grows larger over time, the plaster and walls disintegrate. The resultant cracks are susceptible to water infiltration, exacerbating moisture-related problems.



*Plant roots can penetrate through the building fabric and can result in extensive cracking if not addressed quickly.*

### WATER RETENTION

Water retained by the roots of the plant/algae will result in further deterioration of the ageing building materials, by inducing damage such as salt attack, corrosion of embedded steel and swelling.


## Manmade Factors

A lot of deterioration seen in buildings is a result of neglect, or simply ignorance of the potential impacts of an action to the building. Commonly seen manmade causes and problems include the following:

Cause	Common Symptoms
Soil settlement and vibrations from adjacent traffic/ neighbouring construction activities, e.g., tunnelling works	<ul style="list-style-type: none"> <li>• Cracking</li> <li>• Enlargement of existing cracks</li> </ul>
Heavy foot and vehicular traffic, especially machineries	<ul style="list-style-type: none"> <li>• Wearing down of surfaces</li> <li>• Chipping/cracking of edges</li> </ul>
Installation of services that require demolition, or chasing of pipes, wiring through walls and floors	<ul style="list-style-type: none"> <li>• Demolition/puncturing of walls</li> <li>• Disintegration of walls</li> </ul>
Neglect/poor maintenance habits	<ul style="list-style-type: none"> <li>• Pest infestation</li> <li>• Trapped moisture, causing mould and fungi growth</li> <li>• Termite infestation</li> </ul>

*Heavily used paths and steps may be worn down at a quicker rate.*



 What does it mean to do the 'right' or 'wrong' action to a building? Find out [here](#).

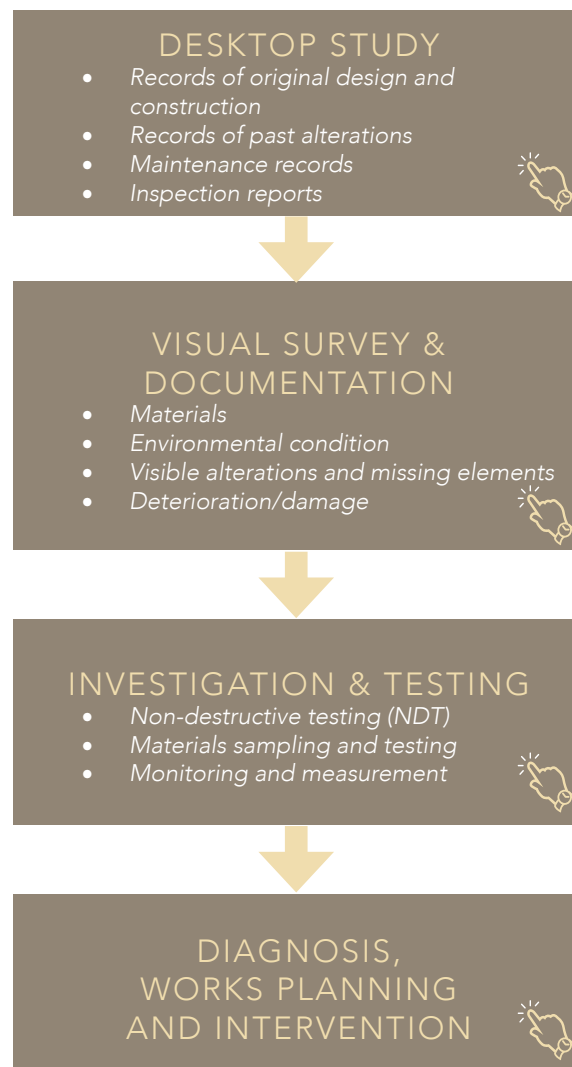
In many cases encountered in Singapore, damage in a historic building actually comes about due to a lack of knowledge of what is the right or wrong action on the building. Always research and ask for complete information on compatibility before doing any work on your building.



**4 | ASSESSING THE CONDITION  
OF YOUR BUILDING**

## Condition Survey | Overview

Knowledge about the physical health and intactness of your historic building will aid in planning what works are needed to restore it. Similar to a health checkup, study of past records, assessment of visible symptoms, screening using specialised equipment, sampling and laboratory tests will yield vital data on the 'state of health' of your heritage building. The information will be synthesized and analyzed to arrived at a diagnosis, which will inform the conservation works planning. This chapter covers the main causes and key investigation methods of common deterioration, as well as key restoration methods.



## Desktop Study

All available existing records should be requested, retrieved and compiled at the beginning of any condition survey. This will provide a preliminary understanding of the building, and possibly reveal issues to look out for, facilitating the planning of on-site survey and investigation work. Key documents include:

- Past survey or renovation drawings and photographs
- Maintenance records
- Past survey, inspection and test reports

For example, past drawings may show that the building was constructed in phases using materials and techniques of differing periods and quality. This will provide clues to where the building joints are and inform the drawing up of the investigation and sampling plan so that the full range of materials across the various extension phases is covered.

Understanding the building via desktop study of available literature and records and planning the survey ahead will help to streamline and focus the fieldwork.

## Visual Survey and Documentation



Use sample *investigation checklist* at the back of this volume to help you take notes on your building's condition.

A detailed dilapidation and visual survey should then be carried out to record the following:

- Current use of the building
- Materials used in the building fabric and elements with differentiation on architectural and structural elements, including all services like plumbing and electrical and mechanical fixtures
- Types, symptoms and distribution of any deterioration and damage
- Exposure condition, local and general environment
- Alterations to the building
- Missing elements
- Drainage such as gutters, rainwater downpipes
- Surrounding landscape such as slopes, soil settlement, etc.

Your documentation can be simple, in the form of written notes, sketches with annotations, as well as audio and video recordings. Other ways include photographs, sketches and drawings of the different defects onto available building plans.



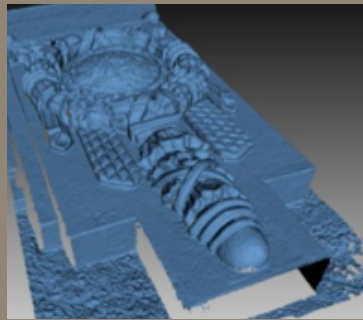


## DOCUMENTATION OF ORNAMENTAL PLASTERWORKS

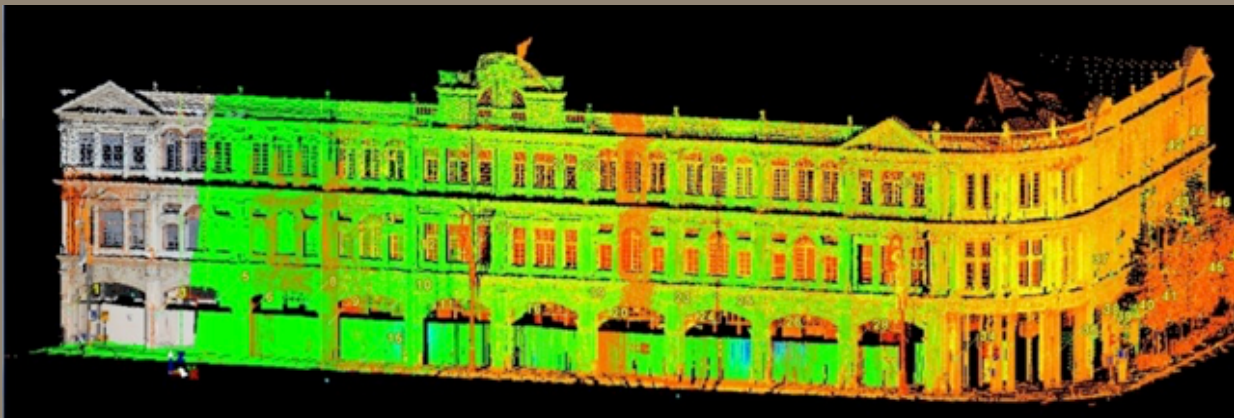
There are several ways in which ornamental plasterworks and intricate features can be recorded for restoration and future repair, ranging from traditional methods to high-tech methods involving laser/optical scanning. In recent years, digital 3D modelling is gaining popularity due to its ability to capture very fine detailed dimensions, and the possibility of creating a 3D-printed replica as an off-site reference.



LEFT: A profile gauge for recording simple profiles on cornices.  
ABOVE: Replica created from a silicone mould.



FROM LEFT: 3D scanning in progress; output data from a 3D scanning; and samples of replicas from 3D printing.



3D Scanning of buildings.

## Investigation, Testing and Monitoring

Beyond visual assessment of your building, you could engage a specialist to conduct further detailed investigation and testing, to provide more in-depth analysis of your building's condition, especially when the defect is hidden under the surface. This will provide more details that will inform the restoration method and technical specifications, such as information on the historic material (e.g., Shanghai plaster composition, roof beam timber species), causes and extent of deterioration (e.g., plaster failure due to rising damp). Depending on the method used, you can find out:

- The type and nature of the historic building material(s)
- Details of construction, such as thickness, dimensions, presence of cavities, embedded objects
- Presence and extent of defects, distress, damage and deterioration
- Causes of the defects, distress, damage and deterioration
- Serviceability of the materials, elements or components for the intended future use

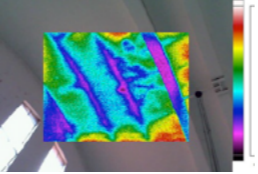

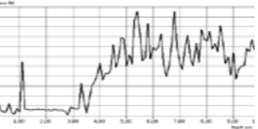
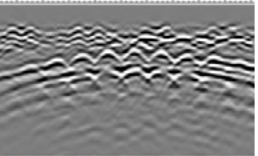
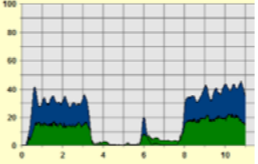
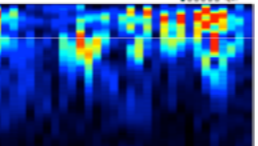
Methods of investigation vary in level of invasiveness, from non-destructive tests to breakout inspections and extraction of materials for laboratory analysis. Given the sensitiveness of historic buildings, especially when dealing with ornamental finishes, any removal of material should be minimized and limited to strategic points. As far as possible, non-destructive means are always recommended to be first considered.

### NON-DESTRUCTIVE TESTING

A host of non-destructive testing (NDT) methods are available for different applications, from traditional methods to state-of-the-art techniques.

Some of the commonly used methods are summarized in the table on the following page.



Name of Non-Destructive Test (NDT)	What material can I use it on?	What do I want to find out?							How it works	Points to note	
		Presence of voids/cavities	Presence of trapped moisture	Presence of embedded elements (e.g. steel reinforcement)	Structural integrity	Strength/density	Type of material	Measure thickness of member			
<b>INFRARED THERMOGRAPHY (IRT)</b>	Most materials	✓	✓	✓						Measures variations in wall surface temperature, since elements under the surface (e.g., air voids, moisture, different materials) will conduct heat differently	Useful for gaining a quick glance of the condition, but needs to be supplemented with other tests if accurate measurements are needed.
<b>MICROWAVE MOISTURE TOMOGRAPHY (MMT)</b>	Most materials		✓							Emits microwave energy into the wall, which causes water molecules trapped under the wall surface to vibrate. The more vibration is detected, the more moisture is present.	MMT can be used to investigate large sections of a wall non-destructively, as compared to the conventional approach of drilling of powder at multiple points for laboratory testing, which can be labour-intensive as well as cause unsightly damage to the walls.
<b>DRILL RESISTANCE MEASUREMENT SYSTEM (DRMS)</b>	Brick, Stone	✓			✓	✓				Measures the force required to drill a hole throughout the thickness of a brick/stone wall, to determine how strong/weak the wall is.	DRMS is not strictly non-destructive as a small hole is drilled into the wall.
<b>GROUND PENETRATING RADAR (GPR)</b>	Most materials	✓		✓	✓		✓	✓		Transmits electromagnetic waves through the structure, and measures the signal that is sent back, to determine differing materials under the surface.	
<b>TIMBER RESISTOGRAPHY (TR)</b>	Timber	✓			✓	✓				Measures the force required to drill a hole throughout the thickness of the wood. Greater force required implies strength, while lesser force required implies soft, decaying wood, presence of cavities or termite attack within the timber member.	TR is not strictly non-destructive as a very small hole of about 3–6mm is drilled into the timber. However, it allows one to very easily ascertain the condition of a piece of wood without compromising its integrity.
<b>ULTRASONIC PULSE ECHO TOMOGRAPHY (USPET)</b>	Concrete	✓	✓	✓	✓			✓		Transmits ultrasonic pulses through the concrete and measures the signal that is sent back, to detect internal disturbances that are not visible on the surface, such as voids, cracks, embedded structures, etc.	

## MATERIAL SAMPLING AND LABORATORY ANALYSIS

Because historic building materials can differ from today's construction materials, samples are sometimes extracted for testing in the lab, in order to better understand how to restore the building. Samples can be used to determine:

- the type and composition of the materials
- characteristics of the materials, such as porosity, colours, density, permeability, thermal stability, etc.
- quality, strength and integrity of the material
- causes and extent of degradation due to weathering, chemical attack or salt attack

Results from materials analysis have been used in projects to facilitate the development of methodologies for intervention, selection of the most suitable materials/chemicals for treatment, and assessment of the serviceability of the historic material.



*Sampling for investigation can be invasive, commonly requiring controlled 'breakouts' and drilling of materials for processing in the lab.*

Although highly useful, the process of sampling is also more invasive, since drilling and cutting into the building fabric is needed to obtain samples. Hence, it is recommended that a sampling plan is created to consider the types, locations and amounts of samples to be extracted.

The table on the following page lists a few of the most relevant laboratory tests available for testing of historic building materials, and typical applications. These tests are generally carried out by materials specialist laboratories.

Name of Laboratory Test	Commonly Tested Materials	Typical Applications
Fourier Transformed Infrared Spectroscopy (FTIR)	Plastics, paints	<ul style="list-style-type: none"> <li>Identify type of paint finish</li> <li>Identify type of material (organic or inorganic) when there are unknowns</li> </ul>
Scanning Electron Microscopy Energy Dispersive X-Ray Analysis (SEM-EDX)	Most materials	<ul style="list-style-type: none"> <li>Provide high-resolution image of sample surface (e.g., corroded metal surface)</li> <li>Understand nature of pitting and pinholes in material surfaces</li> </ul>
X-Ray Fluorescence (XRF)	Metals	<ul style="list-style-type: none"> <li>Identify type and composition of metals, especially alloys</li> <li></li> </ul>
Ion Chromatography (IC)	Salts	<ul style="list-style-type: none"> <li>Determine type of salt that is attacking the building material</li> </ul>
Petrographic Analysis	Brick, plaster, concrete, renders	<ul style="list-style-type: none"> <li>Determine composition of material, such as size, material, type and colour of binders and aggregates</li> </ul>
Metallurgy	Metals	<ul style="list-style-type: none"> <li>Study quality of metal and extent of corrosion</li> </ul>
Thermal Gravimetric Analysis (TGA)	Most materials	<ul style="list-style-type: none"> <li>Understand the material's response to temperature</li> </ul>



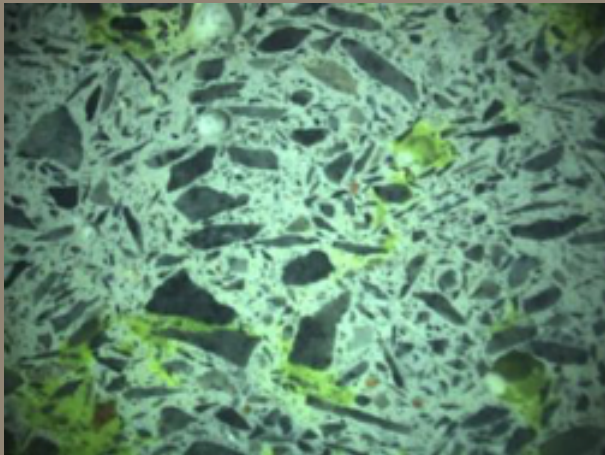
## PETROGRAPHY ANALYSIS

One of the most powerful and useful lab analysis techniques is petrographic examination under a microscope, commonly used for concrete, plaster, stone, tiles and clay bricks. This technique involves the examination of polished sections and 'thin sections' at different magnifications, from 1x up to 10,000x magnification.

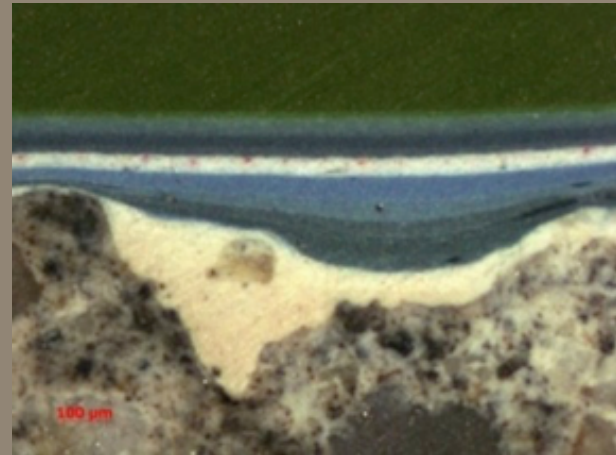


*From left: hand sample, polished section and thin section of about 20um thick.*

Depending on the scale of magnification, different information can be obtained from samples. At the lowest magnifications, information such as the colour, distribution, size of aggregates and different layers can be discerned. Under the stereo-microscope (10x–100x), impurities can be detected. At even higher magnifications, types of chemicals (e.g., cement, lime) can be recognized. By adding other conditions such as shining ultraviolet (UV) light onto the sample, or applying fluorescent dyes, a myriad of other information can also be obtained that would otherwise be invisible under normal conditions. This includes colour and thickness of multiple layers of paint, presence of pores and cracks, types of finishes, past treatments, decay, etc.



*A polished section of Shanghai plaster made up of white Portland cement and crushed granite chips.*



*Layers of paint can be discerned in the polished section.*



*Avongard Tell-Tale crack gauge for monitoring changes in crack widths.*



*Attached permanently to the side of historic buildings, a tilt plate provides a constant point from which measurements can be taken, using a separate handheld device. Changes are found by comparing the current reading to the previous recorded reading.*

## MONITORING & MEASUREMENTS

In certain cases, it may be necessary to monitor the building's behavior and response to changes in the environment. This is usually done by installing of sensors for data collection over a prolonged period. Some examples of information that can be measured include:

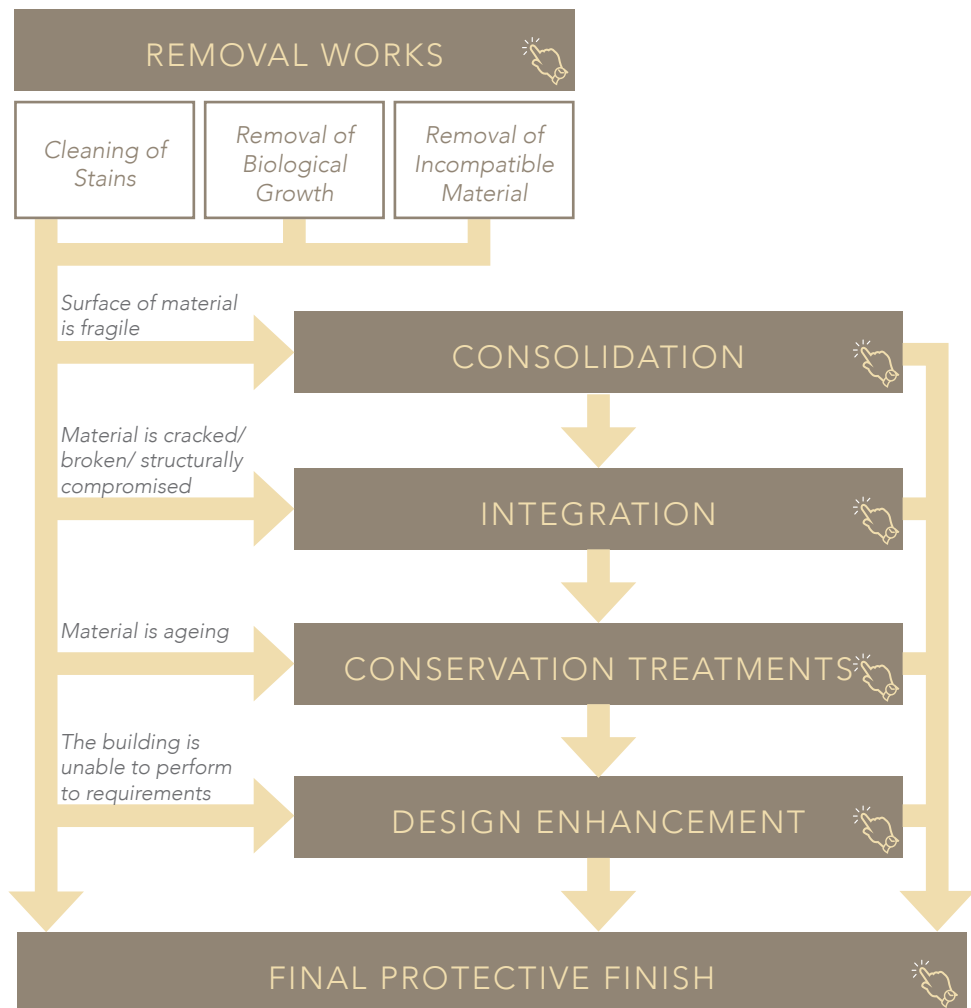
- **Crack movements** - Cracks may be monitored to assess if the cracks are 'live', i.e. continuously growing.
- **Building movements** - The extent, direction and degree of tilting can be measured to understand the potential structural risks. Where construction is ongoing nearby, vibration intensity can also be monitored, with alarm systems to actively alert against destructive vibrations.
- **Ground movements** - Potential ground settlement/heave, or changes in the ground water level and pressure around or under buildings can be predicted based on measurements, in order to carry out necessary protection of the building.
- **Hygrothermal movements** - Heat and vapour flows through the building envelope are measured to understand the response of the building to changes in the environment. A common use for this is to understand if the historic building can be converted from naturally ventilated to air-conditioned use, and whether interventions are needed to insulate the walls, to prevent high energy consumption.



**5 |  
RESTORING YOUR BUILDING  
– KEY METHODS**

## Methods of Restoration | Overview

Although there are many methods to restore a building depending on its age, condition, materials and needs, the works can be generally grouped into a few categories, which are introduced within this chapter. The flowchart below summarizes the stages of works according to the sequence in a typical restoration scope for a building.



Detailed methods of restoration for specific elements and materials will be further elaborated in later volumes of this series.



One of the gentlest ways to remove dirt from external walls is the use of rotary jet blasting. Tiny glass beads are discharged under controlled pressure and at a tangential angle to gently 'rub' the dirt off without cutting the surface.

## Removal Works

Removal work is the essential first step to restoration of a historic building, and it is necessary prior to any restoration works to expose the extent and pattern of any underlying problems. For example, cracks may be hidden under dirt, algae growth, or thick layers of paint on the building façade.

### CLEANING

Heavy staining due to accumulation of surface dirt can obscure ornamental details or the colour of the façade. Several cleaning methods and services are available in the industry for different types of buildings and materials, but the most expensive or complicated methods may not necessarily be the best for your building. Unlike with newer modern buildings, the simplest and gentlest methods are always first recommended for a historic building, to prevent damage to the sensitive historic fabric.



There are new emerging technologies that allow for effective cleaning without the need to handle large amount of waste, by using dry ice or laser.

Other considerations include:

- whether there will be chemical/physical damage to the treated surface
- whether the material is sensitive to water
- the type of dirt to be removed
- the run-off from cleaning should ideally be environmentally friendly



Recall - plants can cause *extensive damage* to a building.

### BIOLOGICAL TREATMENT

The growth of plants, algae and fungi accelerates deterioration of building material, in addition to being unsightly.

It is recommended to first remove paint coatings around the affected area to uncover any plant growth that may be hidden underneath. Generally, plants are removed by hand, before the application of herbicide to break down roots that may have penetrated the walls.



To deal with algae or fungal (mould) growth, natural or synthetic algaecide or fungicide may be used to kill and prevent further growth. Biodegradable algaecides and fungicides are recommended as these will not leave any hazardous residue on the surface.

### REMOVAL OF INCOMPATIBLE MATERIALS

Restoration work often entails undoing past inappropriate works, especially where these have accelerated degradation of historic materials. A common example in Singapore is the removal of thick layers of emulsion paint that trap moisture inside historic brick walls, aggravating building deterioration.



Recall - many building defects are caused or made worse by *moisture* in the building fabric.

In some cases, historic material may have been found to be unsafe and will need to be removed. For example, asbestos, a popular roofing and fireproofing material used since the early 1900s, has been found to be hazardous to health and is now required by law to be removed if found.



### “WRONG” METHODS OF RESTORATION

Often, due to a lack of knowledge of the material properties of historic buildings, owners, contractors and even building professionals may use the wrong methods when attempting to address defects. Despite their good intentions, they inadvertently end up causing even more damage to the building.

Some commonly seen mistakes, and their resulting effects, are shown below:



*Use of Portland cement-based plaster or epoxy adhesives over traditional lime plaster that traps moisture in the wall. The salts deposited by the moisture gradually build up under the cement, pushing outwards and causing the entire coating to crack.*



*Use of Portland cement mortar as pointing for historic brickworks. The softer brick decays and leaves only the harder cement mortar in place.*



*Application of film-forming paint over historic lime plastered wall, resulting in 'powdery' friable plaster underneath.*

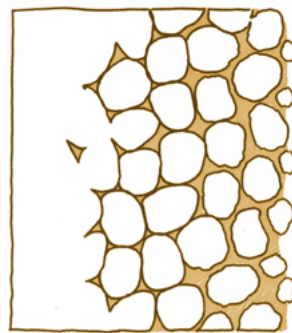


Consolidation can take the form of a layer of cheese-cloth or rice paper to hold the fragile surfaces together as an interim measure while restoration methods for it are being developed.

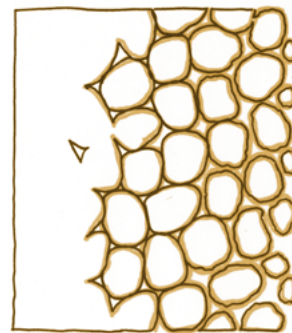
## Consolidation

Years of exposure to the weather and environment can result in erosion of wall surfaces, flaking of paintwork (especially of concern in mural or fresco art), or increasingly porous plaster finishes. The purpose of consolidation treatment is to rebuild the stability of such fragile surfaces, so that they become stable enough to withstand further restoration work. Depending on the condition of the fragile surface, such treatment used can be temporary and reversible, or permanent.

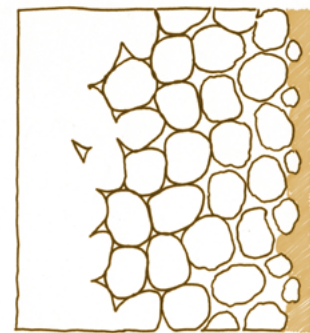
### MECHANISM BEHIND DIFFERENT TYPES OF CONSOLIDANTS



Consolidant injected within the pores of material



Consolidant coats the loose material and bonds them at contact points



Consolidant is applied on the surface to bind the loose material



Depending on the type of substrate, different consolidants will need to be selected, but it is best to seek the advice of a conservation specialist if you are unsure.

To further ensure suitability and effectiveness, trial applications can be used and verified through tests.

More permanent but potentially damaging solutions work by penetrating into the substrate and solidifying within the pores, or reacting chemically to re-bond loose material. For this reason, it is important that the consolidant is chemically compatible. Conversely, the use of incompatible consolidants can result in:

- Surface hardening, which can lead to eventual delamination of the entire consolidated surface
- Alteration in the appearance of the treated surface, e.g., darkening
- Excessive vapour impermeability, which can lead to moisture being trapped within the walls

## Integration



*Tiles with minor chipped edges can be left in place, since it will be costly to repair the tile, with very minimal visual benefit.*

Integration refers to works that restore the ‘integrity’ of the historic fabric, such as repairs of cracks or broken-off elements, or even replacement of components that are damaged beyond repair. When identifying works for repair, it may be worthwhile to bear in mind that wear and tear are a given for any heritage building. It is not necessary to address all signs of ageing that are mainly aesthetic and do not affect building performance, such as minor chips, hairline cracks and slight discolourations. In fact, the patina of age gives heritage buildings character. In such cases, it is generally recommended to leave them unrepaired, and prioritize resources for other more urgent works.

Sometimes, damage of a historic material is so extensive that the element becomes structurally compromised. However, there are many methods of structural repair available that allow for partial replacements, enabling retention of intact historic material where possible without compromising building performance or safety. For example, a historic timber window frame with wet rot at the bottom can have just the damaged sections replaced by splicing, to preserve as much of the high-quality original wood and craftsmanship as possible. It is recommended to explore this approach rather than wholesale replacement.

In devising integration strategies for heritage buildings, the best practices use materials that are compatible with the existing (and, ideally, reversible), respecting the physical, mechanical and chemical properties of the historic fabric. Care needs to be taken to ensure the repair does not end up damaging the historic material or cause problems down the road.

 *Investigative tests* carried out by specialists will help you to understand the extent of treatments needed for your building.

## Conservation Treatments

To lengthen the lifespan of historic materials for future use, conservation treatments are available for different materials. Conservation specialists could advice on the appropriate treatments needed for your building. The typical treatments commonly encountered in conservation works in Singapore are shown in the table below:

Typical Substrates	Typical Treatments Used	Purpose
Masonry walls	<ul style="list-style-type: none"> <li>• Rising damp treatment</li> <li>• Salt treatment</li> </ul>	<ul style="list-style-type: none"> <li>• To insert a barrier so that groundwater is unable to travel up into the wall</li> <li>• To remove damage-inducing salts previously carried upwards by groundwater</li> </ul>
Plaster wall/exposed masonry wall/fairfaced concrete	<ul style="list-style-type: none"> <li>• Water repellent treatment</li> </ul>	<ul style="list-style-type: none"> <li>• Minimizes water ingress, while remaining breathable so that moisture is not trapped within the walls</li> </ul>
Timber	<ul style="list-style-type: none"> <li>• Preservative treatment</li> </ul>	<ul style="list-style-type: none"> <li>• Controls wood degradation due to fungal attack or insect attack</li> </ul>
Reinforced concrete	<ul style="list-style-type: none"> <li>• Corrosion inhibitor treatment</li> </ul>	<ul style="list-style-type: none"> <li>• Protects metal reinforcements from corrosion-inducing substances</li> </ul>
Iron/steel	<ul style="list-style-type: none"> <li>• Corrosion treatment</li> <li>• Anti-rust treatment</li> </ul>	<ul style="list-style-type: none"> <li>• Protects metal surface from corrosion-inducing substances</li> <li>• Treats and repairs corroded surfaces</li> </ul>

## Design Enhancement



*A good example of an additive design enhancement is the addition of a protective glass panel on the external side of stained glass panels, to protect the delicate stained glass from damage.*

Design enhancement is deployed to address shortcomings in the original design that may be affecting building performance, and also when historic buildings are being remodelled for a different function. Components of the building may be modified, added to or reconstructed in this process. To ensure the historic material is kept intact, it is generally a good idea to explore solutions that are additive (adding on parts) rather than reductive (taking away parts) as well as reversible.

Where safety is a concern, or where new uses call for a higher design loading, historic buildings may also undergo structural strengthening where the existing structural system is augmented. This is commonly done in earthquake-prone countries that have strict seismic requirements on their buildings.

Strengthening measures for historic buildings can be highly invasive and damaging and should be carefully and rigorously developed. It is recommended to engage specialist conservation structural engineers and builders, who will be able to advise on detailed structural investigation and the best methods and technologies, and provide customized solutions. The best practices use methods that are sensitively tailored to minimise impact on the historic fabric, while ensuring the building can continue to be safely and practically used.

## Protective Finish



Recall - *incompatible protective finishes* can cause more harm to your building.

Upon completion of restoration works, the final protection finish is important to act as a surface barrier against future environmental stresses. Such finishes include paints, varnishes and repellent treatments.

When selecting the final finish, it is important to choose compatible materials that work well with the historic materials. The table below shows typical protective finishes used for different materials, and key considerations in each case.

Typical substrates	Typical protective finish used for historic buildings	Points to note
Plaster walls (especially for walls plastered with lime)	<ul style="list-style-type: none"> <li>• Mineral silicate paints</li> <li>• Lime wash</li> <li>• Silicone paints</li> </ul>	<ul style="list-style-type: none"> <li>• The paint finish should be breathable to ensure moisture does not get trapped within the walls.</li> <li>• Choice of paint should be suitable to the environment exposure and required lifespan.</li> </ul>
Iron/steel	<ul style="list-style-type: none"> <li>• Zinc-rich anti-rust primer</li> <li>• Micaceous iron-oxide epoxy primer</li> <li>• Polyurethane final coating</li> </ul>	<ul style="list-style-type: none"> <li>• The primer coat prevents corrosion of the metal surface, while the final finish protects the primer from UV damage.</li> </ul>
Timber	<ul style="list-style-type: none"> <li>• Anti-termite coatings</li> <li>• Aluminium paints followed by enamel paint finish</li> <li>• Polyurethane or linseed oil varnish (for exposed timber surface)</li> </ul>	<ul style="list-style-type: none"> <li>• Timber is most sensitive to moisture exposure, which causes a series of defects such as warping and proneness to termite attacks.</li> </ul>

# **RESOURCES**





**OTHER USEFUL INFORMATION**

## Heritage and the Law in Singapore

Singapore's architectural heritage is protected by two legal acts: the Planning Act (1998) and the Preservation of Monuments Act (2009). Between them, the two acts cover over 7,200 heritage structures in Singapore. These acts differ in their scope and how they are enforced. If you own or rent a historic building, or if you are an architect engaged to work on an old building, it is a good idea to know the difference between the two pieces of legislation.

The vast majority of Singapore's built heritage consists of shophouses, as well as a considerable number of historic bungalows. These are gazetted as conserved buildings under the Planning Act.

Sites of greater social, historic or religious significance are listed as national monuments under the Preservation of Monuments Act. At present, there are 72 national monuments in Singapore. The list of monuments includes religious buildings – such as Thian Hock Keng, Sultan Mosque, Sri Mariamman Temple and the Armenian Church – and historic sites such as the Old Supreme Court and the former Ford Motor Factory.

If your building is a conserved building, the relevant authority is the Urban Redevelopment Authority (URA). If you are a custodian of a national monument, then the relevant authority is the Preservation of Sites and Monuments Division (PSM) (previously known as the Preservation of Monuments Board [PMB]) of the National Heritage Board (NHB).

You can view the Planning Act on the Singapore Statutes Online website, at [this link](#).



### THE PLANNING ACT (1998)

The Planning Act is the Act of Parliament that covers Singapore's built environment. The act sets out the rules for all construction, renovation and demolition work in the city state. For this reason, it is useful for building owners to acquaint themselves with their rights and responsibilities set out in this act.

Refer to [this website](#) for more information on the conservation guidelines, including whether your building is in a conservation area.



Under Section 11 of the Act, URA issues 'Conservation Guidelines' for the protection of conservation areas. These guidelines are made available for inspection and sale to the public.

As a heritage building owner, you need to know if your building falls within the designated conservation areas, and if so, be aware that carrying out works without the requisite conservation permission is considered a breach of legislation. Building owners who breach planning control may be liable to legal penalties.

While you should take the URA guidelines as a starting point for all work on your heritage building, it is worth noting that guidelines are by their nature general. Guidelines cannot take into account the specifics of every conserved building, or accommodate their individual idiosyncrasies. There may therefore be times when the guidelines do not adequately address your building. If you need to depart from the guidelines, it is crucial that rigorous research is conducted so that a case for this departure can be presented to the authorities.

You can view the Preservation of Monuments Act on the Singapore Statutes Online website, at [this link](#).




## THE PRESERVATION OF MONUMENTS ACT (2009)

Unlike the Planning Act, which covers the built environment as a whole, the Preservation of Monuments Act is much more focused. This act's sole purpose is "to provide for the preservation and protection of national monuments by the National Heritage Board and for matters connected therewith". Today, there are 72 buildings and structures that have been listed as national monuments by the NHB.

As custodians of sites of great historic value, both owners and occupiers of national monuments have additional responsibilities towards their buildings. According to the Preservation of Monuments Act:

*It shall be the duty of the owner and the occupier of any national monument to take all reasonable measures to ensure that the national monument is properly maintained at all times in accordance with such guidelines as may be issued by the Board.*

The Preservation Guidelines (PGL) are produced specifically for each national monument, and are made available to you if you are the owner.

You may also refer to [this website](#) to view the Technical Guidelines issued by PSM. 

The act also forbids any demolition, reconstruction, alteration, repairs, renovations or repainting – among other things – without prior written permission by PSM. These rules are laid out in ‘Preservation Guidelines’ (PGL) for each monument. PSM also has a set of technical guidelines which function as advisory notes related to the conservation, repair, maintenance and management of the monuments, although these are not part of any legislated standards.

Compared to conserved buildings, national monuments are subject to considerably more stringent rules and regulations. Non-compliance is a serious offence, and individuals found guilty of non-compliance may be liable to large fines and a jail term. It is therefore vital for the custodians of national monuments to get to know the Preservation of Monuments Act.

## International Charters and Principles

*People are becoming more and more conscious of the unity of human values and regard ancient monuments as a common heritage. The common responsibility to safeguard them for future generations is recognized. It is our duty to hand them on in the full richness of their authenticity.*

ICOMOS, The Venice Charter, 1964.

A number of principles and agreements provide the framework for professional ethics and best practice in heritage worldwide. These documents have been issued by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Council on Monuments and Sites (ICOMOS), an advisory body of UNESCO's World Heritage Committee. Many charters and conventions have been issued over the last century, but three in particular are worth knowing.

You can view the Venice Charter on the official ICOMOS website, at [this link](#).



### THE VENICE CHARTER (1964)

The first set of principles to know are set out in a document called the Venice Charter. Drafted in 1964, the International Charter for the Conservation and Restoration of Monuments and Sites was a response to the wave of reconstruction that followed the devastation caused by World War II. The charter outlines key ideas that guide conservation work to this day.

The Venice Charter is significant for a number of reasons. It stresses the importance of material authenticity and context. It highlights the need for scientific, historical, and archaeological research to support conservation, and the importance of documentation. Significantly, the Venice Charter highlights both the national and international dimensions of conservation – and the need for local laws to work together with international principles.

The Venice Charter promotes the idea of material authenticity. The charter recognizes that buildings evolve over time, and that additions to historic buildings are evidence of their history.

*The valid contributions of all periods to the building of a monument must be respected, since unity of style is not the aim of a restoration. When a building includes the superimposed work of different periods, the revealing of the underlying state can only be justified in exceptional circumstances.*

The Venice Charter treats buildings as historical objects, whose story can be read in the various changes and accretions that accumulate over time.

According to the Venice Charter, historic buildings are not just works of architecture, but “living witnesses” that are “imbued with a message from the past”. While later charters and conventions have nuanced our understanding of heritage further, the notion of authenticity outlined in the Venice Charter remains at the heart of historic conservation work today.

You can view the most updated version (2013) as well as illustrated and previous versions of the Burra Charter on the ICOMOS Australia website, at [this link](#).



## THE BURRA CHARTER (1979)

While the Venice Charter provides the framework for building conservation today, it is largely focused on the tangible, material aspect of buildings. While the charter notes the importance of ‘context’, the charter focuses on the physical context.

ICOMOS Australia played a crucial role in expanding what conservation means. The Burra Charter, first issued in 1979 and most recently updated in 2013, puts forward a broader view of heritage. The Burra Charter emphasizes both ‘place’ and ‘cultural significance’ in conservation. The charter defines ‘place’ expansively:

*Place means a geographically defined area. It may include elements, objects, spaces and views. Place may have tangible and intangible dimensions. (Article 1.1)*

This moves conservation well beyond the Venice Charter's relatively narrow focus on 'monuments and sites'.

The Burra Charter came out of a specific cultural context: heritage professionals in Australia needed an inclusive framework for indigenous Australian heritage sites, where human interventions are often situated in places of great natural beauty and are overlaid with spiritual and historical significance. As a result, the relationship between people and place is at the heart of the Burra Charter, which states:

*Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. (Article 1.2)*

You can view the Nara Document on the official ICOMOS website, at [this link](#).



## THE NARA DOCUMENT ON AUTHENTICITY (1994)

The Nara Document on Authenticity adds further nuance to heritage philosophy. Western heritage principles have tended to focus on the bricks and mortar – and as a result advocated 'maximum retention, minimum intervention' in building materials. This is not always appropriate in other parts of the world, however, especially in Asia.

The widespread use of organic materials such as wood, paper and attap in construction makes a purely materialistic view of heritage unfeasible in much of Asia. Compared with steel, concrete or masonry buildings, organic building materials decay at a much faster rate. In much of Asia, conservation must therefore focus on methods of building and traditional craftsmanship, so that historic buildings can be regularly renewed. The building remains, even as the actual fabric of the building is constantly being renewed. In the words of Heraclitus, "ever-newer waters flow on those who step into the same rivers".

Sometimes, the cultural context of a heritage building puts it in direct conflict with the conservation principles set out in the Venice Charter. The Grand Shrine at Ise in Japan is a classic example. The shrine has been ceremonially demolished and rebuilt every 20 years for centuries. This process of rebuilding is a key ritual at the most sacred site in Shintoism. But this goes directly against the conservation principles outlined in the Venice Charter. How do we address this kind of conflict between conservation practice and cultural significance?

The Nara Document recognizes that different approaches to conservation arise from different cultural contexts. This does not make conservation practices in Asia any less authentic than their Western counterparts. The Nara Document celebrates the diversity of human cultures and asks that we respect “the legitimacy of the cultural values of all parties” even “where cultural values appear to be in conflict”.



## What Kind of Professionals Do I Need?

Conservation works take on a range of scales, from small minor checks and repairs that you can do yourself to full-scale restorations requiring qualified experts and authority approvals. Furthermore, since the nature of conservation can be very different from other more generic building works, it is always good to look for people with knowledge, training or prior experience in conservation who can advise you on things you need to be sensitive to when treating your heritage building.

The list below provides a description of the typical scope and services of various professional persons, to help you understand who is the best person to approach for the works you may require.

### **Architect**

- Advises on the feasibility of your intended works, especially when new works such as extensions are required
- Prepares the design, including visualizations and details
- Prepares the necessary documentation for authority approvals, including drawings, technical specifications and bills of quantities
- Administers the contract between the building owner, contractor, and sometimes other consultants

### **Structural Engineer**

- Assesses the structural integrity of the building
- Advises on the feasibility of your intended works, especially with regards to structural requirements
- Prepares the design, especially when new works such as extensions or retrofits are required
- Prepares the necessary documentation for authority approvals, including drawings and structural calculations

### **Conservation Specialist**

- Advises on the heritage value of your building
- Advises on the feasibility of your intended works, including the design of new works within the heritage site/building
- Manages the conservation of your building
- Advises on appropriate investigation and restoration methods for your building

**Materials Specialist**

- Carries out specialist investigations and laboratory tests to understand the requirements of your building
- Assesses the condition and serviceability (lifespan) of your building
- Recommends appropriate solutions for deterioration in the building fabric

**Quantity Surveyor**

- Estimates the cost of the work to be done, based on the details of the design
- Monitors the costs during the course of restoration



It is advisable to look for an experienced contractor who is familiar with the practical requirements of old buildings.

Do note that there are also specialist restorers who can carry out repairs to specific historic elements, such as paintings and stained glass, or historic materials such as cast iron.

**Specialist Builder/Contractor**

- Carries out the works according to the design and conservation programme, in a safe manner
- Manages the works on the site, including coordination with sub-contractors for works requiring other expertise
- Sources for suppliers of required materials for restoration



**USEFUL WORKSHEETS**

Things you will need:

- A printout of this checklist
- Pen/pencil
- A camera, preferably with a good zoom function
- Extra sheets of paper



## Sample Checklist: What Is Unique about My Building?



Have you read *Noting Down Physical Characteristics of your Heritage Building* in Chapter 1?

FORM	
Shape/massing	<p>If you can, try to observe your building from a higher point (e.g., a nearby tall building), or from across the street.</p> <p>Is your building a simple shape or a combination of shapes? What shapes can you see?</p> <p>Is it tall and narrow? Is it short? Is the shape similar to its neighbours?</p>
<p>Write/draw your observations: (you may wish to append additional sheets of paper)</p>	
Roof	<p>Refer to the <i>illustration</i> on page 40. Can you identify what kind of roof is on your building? Do the sides of the roof extend beyond the building walls? Is the roof visible from the ground? Are there interesting roof accessories, such as chimneys, cupolas, dormer windows or finials?</p>
<p>Write/ draw your observations: (you may wish to append additional sheets of paper)</p>	

FAÇADE	
<b>Openings</b>	<p>What shapes are the windows and doors? Is there a rhythm or pattern to how the windows are arranged? Are there distinctive openings (e.g., large arched doorways/windows, windows with decorative frames, or unusually shaped windows)? Are the windows the same on all levels?</p>
<p>Write/draw your observations: (you may wish to append additional sheets of paper)</p>	
<b>Projections/recessions</b>	<p>Are there areas of the building that project outwards from the main building shape, such as porches, balconies or bay windows? Are there shades or fins above the windows? Are there spaces that appear to be carved into the building, such as five-foot ways?</p>
<p>Write/draw your observations: (you may wish to append additional sheets of paper)</p>	
<b>Proportion</b>	<p>Is the first storey taller or shorter than the other floors? How big are the openings as compared to the walls?</p>
<p>Write/draw your observations: (you may wish to append additional sheets of paper)</p>	
<b>Composition and relationship within the building</b>	<p>Is there a distinct front façade to the building? How do you know it is the front? How does it compare to other façades (is it larger or more elaborate)?</p>
<p>Write/draw your observations: (you may wish to append additional sheets of paper)</p>	

## MATERIAL/DETAIL

Building materials (Tick all that apply)

**Roof**

- Clay roof tiles
- Metal roof sheets
- Concrete roof
- Other: \_\_\_\_\_

**Ceilings**

- Plaster
- Timber
- Metal
- Other: \_\_\_\_\_

**Façade Walls**

- Plaster
- Stone
- Brick
- Shanghai plaster
- Terrazzo
- Ceramic tiles
- Timber
- Metal
- Glass/glass blocks
- Concrete
- Other: \_\_\_\_\_

**Doors & Windows**

- Timber
- Metal
- Glass
- Stained glass
- Painted glass
- Other: \_\_\_\_\_

**Floors**

- Timber
- Stone
- Cement
- Terracotta
- Cement tiles
- Ceramic tiles
- Other: \_\_\_\_\_

**Staircases**

- Timber
- Concrete
- Stone
- Other: \_\_\_\_\_

Write/draw your observations:  
(you may wish to append additional sheets of paper)

Special details/  
ornaments

Are there special ornamental features, either on the interiors or exteriors, such as mouldings or murals? Are there any fittings with special embellishments, such as decorative rainwater goods, window grilles or ornamented roof finials?

Write/draw your observations:  
(you may wish to append additional sheets of paper)

INTERIORS		
Refer to the notes on <i>Building Types</i> in Chapter 1. What is your building's type?	<input type="checkbox"/> Shophouse <input type="checkbox"/> Bungalow <input type="checkbox"/> School <input type="checkbox"/> Flat/apartment building <input type="checkbox"/> Civic building <input type="checkbox"/> Military building	<input type="checkbox"/> Place of worship <input type="checkbox"/> Industrial building <input type="checkbox"/> Commercial building <input type="checkbox"/> Leisure building <input type="checkbox"/> Other: _____
What spaces are important to your building that relate to the type that you have identified above?	Write/draw your observations: (you may wish to append additional sheets of paper)	
Spatial hierarchy	Is there a distinct main space (e.g., lobby, hall, etc.)? Is it larger and more ornamented than the other spaces within the building? How are the other spaces arranged around it?	
Write/draw your observations: (you may wish to append additional sheets of paper)		
Connective spaces/ Open spaces	Are there special connective spaces, such as corridors, landings or stair halls? Are there open spaces such as atriums, courtyards or airwells? Are these spaces decorated?	
Write/draw your observations: (you may wish to append additional sheets of paper)		
Settings of historic events	Is there any particular room or space where an important event took place? Are there any signs or decorations that commemorate the event within the room?	
Write/draw your observations: (you may wish to append additional sheets of paper)		
Any other observations? Comments? Questions?		

**Things you will need:**

- Inspection checklist-one per side of the building (use the sample below, or prepare your own)
- Floor plans, if available
- Pen/pencil & notebook
- Camera/binoculars
- Flashlight
- Ladder
- Metal probe



## Sample Checklist: Investigating your Building's Condition



Have you read *Assessing the Condition of Your Building* in Chapter 4?

**WHERE DO I START?**

- Start from the ground level. Use a ladder only when areas are too high to reach or see using binoculars or the zoom function of your camera.
- Adopt a systematic approach. Inspect one side at a time, recording your observations on the checklist.

BUILDING SURROUNDINGS	YES	NO	REMARKS/OBSERVATIONS
Is there any water ponding, clogged drains, or poor drainage around the building?	<input type="checkbox"/>	<input type="checkbox"/>	
Are there any trees or plants that are growing very near to the building, causing moisture to accumulate on the walls?	<input type="checkbox"/>	<input type="checkbox"/>	
Are there any lightning protection strips that are broken?	<input type="checkbox"/>	<input type="checkbox"/>	
ROOF	YES	NO	REMARKS/OBSERVATIONS
Are there any missing/broken parts of the roof? If the roof is pitched, is the roof ridge straight?	<input type="checkbox"/>	<input type="checkbox"/>	
(For tile roofs only) Are there missing or broken tiles?	<input type="checkbox"/>	<input type="checkbox"/>	
(For metal roofs only) Do you see any corrosion? Does the metal look like it is wearing thin?	<input type="checkbox"/>	<input type="checkbox"/>	
Is there any sagging?	<input type="checkbox"/>	<input type="checkbox"/>	
Are there any leaks when it rains?	<input type="checkbox"/>	<input type="checkbox"/>	
Are there any plants/algae/moss/mould growing?	<input type="checkbox"/>	<input type="checkbox"/>	
Are there any bird/wasp/insect nests inside the roof?	<input type="checkbox"/>	<input type="checkbox"/>	



(For roofs with timber structure only) Is the timber damp? Do you see any splits, decay or warps? Are there any parts that have been damaged by termites?  YES  NO

ROOF DRAINAGE	YES	NO	REMARKS/OBSERVATIONS
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Are there missing or corroded gutters and/or downpipes?  YES  NO

Are the gutters clean? Are there any leaves or debris causing blockage?  YES  NO

Is there any leakage?  YES  NO

Are there any loose, missing or rusted pieces?  YES  NO

Are there any points where rain water is draining directly onto the wall surface or into the building?  YES  NO

EXTERNAL WALLS	YES	NO	REMARKS/OBSERVATIONS
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Are there any plants, mould or algae growing directly on the walls?  YES  NO

Are there any bird droppings on the walls?  YES  NO

Are there water stains/drip marks?  YES  NO

Are there any cracks, gaps or holes in the walls?  YES  NO

If the wall is painted, is the paint peeling, cracking or blistering? Do you see any white powder forming on the wall surface?  YES  NO

(For brick walls only) Are there any crumbling bricks? Is the mortar between the bricks loose or easily scraped out?  YES  NO

DOORS/ WINDOWS	YES	NO	REMARKS/ OBSERVATIONS
----------------	-----	----	-----------------------

Are there any missing window panels? Are there missing parts?  YES  NO

Are there any cracks or holes in the windows?  YES  NO

(For windows with glass only) Is the putty around the glass cracking, soft, or detached from the glass?  YES  NO

- Do the windows open and close smoothly?
- Does the window ironmongery (handles, lockset, hinges, latches) function properly and smoothly?
- Is there water coming in through or around the window frames?
- If the windows are painted, is the paint peeling, cracking or blistered?
- (For timber windows only) Are there any rotted parts?
- (For metal windows only) Do you see any rusting?

INTERIORS	YES	NO	REMARKS/OBSERVATIONS
Are any wall, floor or ceiling finishes (e.g., tiles) loose or cracked?	<input type="checkbox"/>	<input type="checkbox"/>	
(For painted surfaces) Is the paint peeling, cracking or blistering?	<input type="checkbox"/>	<input type="checkbox"/>	
Are there any damp spots? Does the area smell of mould or mildew? Is the space well-ventilated?	<input type="checkbox"/>	<input type="checkbox"/>	
(For timber elements only) Do you see any splits, decay or warps? Are there any parts that have been damaged by termites?	<input type="checkbox"/>	<input type="checkbox"/>	
Are the stairs and railings in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	
Is there any leaking plumbing in the kitchens or toilets?	<input type="checkbox"/>	<input type="checkbox"/>	
OTHER OBSERVATIONS/REMARKS/COMMENTS			



# Sample Maintenance Log Book

WEEKLY-MONTHLY WORKS	DATE LAST COMPLETED	CONTRACTOR/ MATERIALS USED	NOTES/ OBSERVATIONS
<ul style="list-style-type: none"> <li>• Cleaning of walls (remove dirt/algae/plant growth)</li> <li>• Cleaning of doors and windows</li> <li>• Cleaning of floors</li> </ul>			

QUARTERLY WORKS	DATE LAST COMPLETED	CONTRACTOR/ MATERIALS USED	NOTES/ OBSERVATIONS
<ul style="list-style-type: none"> <li>• Cleaning of gutters and flashing (check for water ponding, choked gutters, remove plant growth)</li> </ul>			

HALF-YEARLY WORKS	DATE LAST COMPLETED	CONTRACTOR/ MATERIALS USED	NOTES/ OBSERVATIONS
<ul style="list-style-type: none"> <li>• Check for broken flashing on the roof</li> <li>• Check for leaking gutters</li> <li>• Check for leaks in rainwater downpipes</li> <li>• Check for warping and cracking of timber floors</li> </ul>			

YEARLY WORKS	DATE LAST COMPLETED	CONTRACTOR/ MATERIALS USED	NOTES/ OBSERVATIONS
<ul style="list-style-type: none"> <li>• Cleaning of roof (remove dirt/ algae/ plant growth)</li> <li>• Cleaning of masonry walls (remove dirt/ algae/ plant growth)</li> <li>• Cleaning of stone/Shanghai plaster/unpainted concrete walls (remove dirt/algae/plant growth)</li> <li>• Check for cracks and leaks in roof and carry out repairs</li> <li>• Check for signs of termite attack</li> </ul>			

EVERY FIVE YEARS	DATE LAST COMPLETED	CONTRACTOR/ MATERIALS USED	NOTES/ OBSERVATIONS
<ul style="list-style-type: none"> <li>• Check for cracks and loose mortar in exposed masonry walls</li> <li>• Check for cracks in stone/Shanghai plaster/unpainted concrete walls</li> <li>• Repaint interior walls</li> <li>• Re-apply anti-termite treatment to doors and windows</li> <li>• Check for cracks and delaminated floor tiles</li> </ul>			

The image features a grid of approximately 12 rectangular panels, each containing a number. The numbers are arranged in a roughly 3x4 pattern, though some are missing or partially obscured. The numbers visible are 11, 12, 13, 14, 40, 41, 42, 43, 44, 47, 58, 59, 60, and 61. The panels have a textured, slightly grainy appearance. The central text 'GLOSSARY OF TERMS' is superimposed over the grid.

***GLOSSARY OF TERMS***

## Glossary | Coming to Terms with Heritage

### ADAPTIVE REUSE

**Adaptive reuse refers to the deployment of an old site or building for a purpose other than that which it was built or designed for, and the modifications made necessary by the change in use (the latter is also known as adaptive remodelling).**

It is a key conservation planning strategy to re-establish the relevance of heritage buildings, especially where the structure has been outgrown, the original use has become obsolete (e.g., opium houses), or the context has undergone major change (e.g., Boat Quay). A good adaptive reuse project begins with identifying an appropriate new use and programme brief that sits well with the building's history, architectural character, scale and interior layout. This would minimize intervention in the original fabric of the building and ensure optimal retention of its heritage value.

### ASSESSMENT OF HERITAGE

**A heritage assessment is a study and evaluation of the historic structure, to determine its significance and inform conservation decision-making.**

Varying in scope depending on its purpose, a heritage assessment may involve desktop study, on-site survey, archival research looking into a building's history, context, current condition, and extant heritage elements. Non-destructive investigation (NDT/NDI) and sampling for laboratory tests may also be carried out to study the historic construction, material palette and condition. This may be followed by a Feasibility Study to determine the conservation project brief and scope. In some countries, Heritage Impact Assessments are commissioned to evaluate the potential impact of planned works on a building's heritage significance, and look into protection and mitigation measures to minimize such impact.

See also [CONSERVATION](#), [FEASIBILITY STUDY](#) and [SIGNIFICANCE](#).

### AUTHENTICITY

**Authenticity of built heritage refers to the extent to which the historic material fabric has or has not been demolished, altered or reconstructed; it also refers to the degree of adherence – during subsequent maintenance, replacement, or reconstruction – to the established construction, artisanal or cultural traditions that produced the building (or its component).**

The latter relates especially to constructions in wood and other organic materials, such as thatch or attap roofs, which have shorter lifespans and in some cultures undergo ritualistic reconstruction.

See also [RECONSTRUCTION](#).

## BUILT HERITAGE

**Built heritage is a subset of the built environment that has been identified as possessing cultural or historical significance.**

It includes buildings, streetscapes, city blocks, structures such as bridges and bus shelters, and infrastructure such as roads, railways and aqueducts.

See also [ASSESSMENT OF HERITAGE](#) and [SIGNIFICANCE](#).

## CONSERVATION

**Conservation of built heritage is the recognition and planned retention of parts of the built environment – from individual buildings to entire city blocks – as heritage.**

It is a process of protection, care and/or sensitively planned interventions on historic structures to prolong their material and design integrity, and retain their historical, social and cultural significance. In planning terms, it is also a process of managing change so that the district or city retains its rich layers of history and diversity.

See also [BUILT HERITAGE](#), [ASSESSMENT OF HERITAGE](#) and [SIGNIFICANCE](#).

## CONSOLIDATION

**Consolidation is the physical addition of materials or application of consolidant treatment to strengthen or support the building fabric to ensure its continued durability and structural integrity.**

See also [INTEGRITY](#), [INTERVENTION](#) and [RESTORATION](#).

## DEMOLITION

**The demolition of parts or the whole of a structure is the intentional destruction and permanent removal of its material fabric.**

Demolition is irreversible. Controlled demolition of inappropriate additions to a historic building is often part of the restoration works – in this case, the method should be carefully devised, with monitoring and protection of the retained structure put in place to avoid collateral damage.

See also [DISMANTLE](#) and [REINSTATEMENT](#).

## DESIGN ENHANCEMENT

**Design enhancement refers to the improvement of inherently defective parts of the original building design, especially where it causes or aggravates deterioration.**

Such enhancements should be sensitively tailored and selectively undertaken, keeping as far as possible to additive and reversible solutions.

See also [INTERVENTION](#).

## DISMANTLE

**To be distinguished from demolition, dismantling works refer to carefully taking apart heritage structures or elements with the intention of reassembling and reinstating them at a later phase; they may also be relocated, or reused in other parts of the conservation project.**

This may apply to fragile artefacts that need to be dismantled for safe storage during the project construction stage, or for elements like windows and doors that are more efficient to restore off-site. To minimize damage and facilitate reinstatement, it is necessary to carefully inventorize, devise the method of dismantling based on a close study of the construction and materials, and document the process.

*See also [DEMOLITION](#) and [REINSTATEMENT](#).*

## FABRIC

**In the context of building, fabric refers to all the physical material, from foundation to roof, from structural members to architectural finishes.**

## FEASIBILITY STUDY

**This is a preliminary study carried out prior to embarking on a major conservation project, especially where it involves intensification and adaptive reuse, to consider what is possible and appropriate.**

Conducted by a multidisciplinary professional team, it is an exercise in exploring design, structural and conservation strategies, budgeting, and resource planning. The relevant conservation regulatory framework and long-term heritage management should also be taken into account. The feasibility study will inform the eventual building programme and project brief.

*See also [ASSESSMENT OF HERITAGE](#) and [CONSERVATION](#).*

## INTEGRITY

**In the context of built heritage, integrity refers to the intactness of historic fabric and architecture or design, or the structural wholeness and strength of the building material.**

## INTERVENTION

**Intervention refers to works being carried out on the historic material fabric and site as part of the conservation process.**

It may range from cleaning, paint removal, repairs and stabilization treatments, to the more invasive such as structural strengthening and replacement. Design intervention involves the introduction of new elements within the historic site or structure, usually for design enhancement, or as part of adaptive reuse or rehabilitation projects. Interventions should be carefully considered and sensitively carried out. They should also be well documented, and any new design elements should be clearly distinguished from the historic.

See also [ADAPTIVE REUSE](#), [DESIGN ENHANCEMENT](#) and [REHABILITATION](#).

## MAINTENANCE

**Maintenance refers to the regular and continuous upkeep of buildings.**

This can include day-to-day cleaning, scheduled maintenance and minor repairs. Careful and appropriate maintenance can extend a building's lifespan and arrest deterioration at the early stage, providing long-term cost savings. It is important to ensure the use of appropriate methods and materials that are compatible with historic fabric in the maintenance of heritage structures. This usually has to be customized for each historic building, and deviates from the standard conventional maintenance regime intended for current-day buildings.

See also [REPAIRS](#).

## PRESERVATION

**Preservation places the highest priority on the protection of existing historic fabric to slow down or arrest any deterioration, with as little change as possible.**

In the local regulatory context, national monuments overseen by the Preservation of Sites and Monuments Division are subjected to the most stringent heritage protection guidelines.

See also [CONSERVATION](#) and [RESTORATION](#).

## RECONSTRUCTION

**Reconstruction involves the recreation of a demolished or collapsed building or part of a building.**

The process may use new materials, salvaged historic materials or a mixture; it may also faithfully replicate traditional construction, deploy new technologies, or be a hybrid of both. Certain building traditions call for reconstruction to extend a building's lifespan, such as the cyclical gopuram renovation of Hindu shrines, or the Chinese *luojiadaxiu* (落架大修, dismantling for major repairs) for major timber structures. Otherwise, demolition and reconstruction of a historic building without due consideration will result in high adverse impact on the authenticity and heritage value of a historic building and should be avoided.

See also [AUTHENTICITY](#) and [REINSTATEMENT](#).



## REHABILITATION

**Rehabilitation is the process of returning a disused and deteriorated historic property to a state of utility, and meeting current-day requirements through careful repair or alteration while conserving its heritage features, value and character.**

Usually referring to old structures or historic districts in poor condition, it may or may not involve a change of use.

See also [ADAPTIVE REUSE](#).

## REINSTATEMENT

**Reinstatement means putting back in place a missing historic element or reversing an inappropriate past alteration, by using a dismantled original or a replacement in the same design and material.**

This can range from minor features – such as ornamental mouldings – to key features such as windows and doors, and major architectural components like walls or roofs. Sometimes, parts of the historic structure are dismantled for off-site restoration or safekeeping; these are then reinstated at a later phase. Reinstatement may also be done for visual coherence and heritage presentation, to ‘complete’ elements with minor missing components, or to replicate defining heritage features that were lost, obscured, or damaged. Authenticity should be taken into consideration, and where possible new replacement materials should be subtly distinguished, for example by assuming a different finish or colour. Sometimes, the losses or modifications of a building are a significant part of its history, and reinstatement may not be desirable – in such cases an alternative is to consider ways to mark or commemorate the lost elements.

See also [AUTHENTICITY](#), [DISMANTLE](#) and [RECONSTRUCTION](#).

## REPAIRS

**Repairs involve fixing broken or faulty building elements.**

Ideally this could be part of regular maintenance, where small problems are flagged and addressed as they occur, using appropriate methods and materials. This will prevent further and more serious deterioration from developing and incurring much higher repair costs. For example, a leaking roof when tackled early may call for just roof tile replacement, while long-term water ingress will inflict more serious damage to the structure and interiors. Where a historic building component has inherent design flaws that cause recurring problems, design enhancement could be considered.

See also [DESIGN ENHANCEMENT](#) and [MAINTENANCE](#).

## RESTORATION

**Restoration refers broadly to the process of treating historic fabric that have been obscured, damaged or altered by insensitive latter-day changes or deterioration, to recover their original attributes as verified through research and investigation.**

The current definition draws largely on the Venice Charter statement that restoration “is to preserve and reveal the aesthetic and historic value of the monument and is based on respect for original material and authentic documents”. Another definition originates from a 19th-century conservation movement, where the term describes the attempt to return or complete a piece of heritage to an imagined ‘original state’ or ‘golden age’ through speculative reconstruction. It was popular till recent years for making dilapidated heritage ‘look good’, but is no longer recommended as good practice due to the highly interventionist approach that often drastically alters the historic fabric and obscures more nuanced layers of history.

See also [AUTHENTICITY](#), [INTERVENTION](#) and [REINSTATEMENT](#).

## RETENTION

**Retention refers to keeping existing built heritage fabric in situ, or in place.**

The term can be applied to entire buildings or elements of buildings. The principle of maximum retention (along with minimum intervention) is a central tenet of built heritage conservation practice today. Wherever possible, heritage structures should be retained to the fullest extent.

See also [CONSERVATION](#) and [REVERSIBILITY](#).

## REVERSIBILITY

**Reversibility refers to the extent and ease with which an intervention or treatment can be removed or undone at a later date, without adversely impacting the original fabric of a heritage building.**

A key idea in current heritage conservation, it is considered good practice that as much as possible, interventions and treatments in a historic building should be reversible. By implication, subtractive interventions that tend to cause irreversible loss, such as removal, hacking and demolition of historic fabric, should be minimised.

See also [INTEGRITY](#) and [INTERVENTION](#).

## SIGNIFICANCE

**The heritage significance of a particular historic building is what makes it important and meaningful to the stakeholders, wider community and/or humanity.**

Also termed as heritage value, it could refer to the building’s fine architectural qualities or craftsmanship, associated historical events or personalities, embodied knowledge, symbolic and/or representative value. Understanding and assessing a building’s significance can aid in its appreciation and protection, help prioritize resources, and inform conservation decision-making. However, significance is also relative and may change through time, or be defined differently by different groups.

See also [ASSESSMENT OF HERITAGE](#) and [BUILT HERITAGE](#).

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