Building Construction of Pre-war Shophouses in George Town
Observed Through a Renovation Case Study

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Abstract
George Town, Penang has the largest collection of shophouses constructed before the Second World War (henceforth pre-war shophouses) in Southeast Asia. The recent increase of shophouse renovations has provided an opportunity to study the building construction, which has not been understood and recorded comprehensively. This paper studies the building construction of shophouses and its transition through observation on eight renovation sites and interviews. The building construction of shophouses was found to exhibit mainly Indian, Chinese and British influence but uses mostly locally available materials. Indian and Chinese influence is stronger in the 19th century shophouses, while western influence is more evident in those of the early 20th century, earmarking the introduction of British policy and western technologies at the turn of the century. However the trend is often blurred by post construction alterations. Although there is a shift to using traditional building materials during recent renovations, changes due to circumstances such as client’s preferences together with heavy use of recycled materials mark another turning point in building construction transition. Proper documentation of renovation processes is crucial for future references and comprehensive understanding of the building construction and its development throughout history.

Keywords: George Town; pre-war shophouses; building construction; transition; renovation

1. Introduction
As a former British trading port, George Town has a multicultural population with Chinese, Indian and Malay as the main communities since the colonial era. In July 2008, George Town was granted UNESCO World Heritage Site (WHS) status in recognition of having a unique architectural and cultural townscape without parallel anywhere in East and Southeast Asia (MPPP, 2008). In particular, George Town was commended for demonstrating an exceptional range of shophouses. George Town has the highest concentration of pre-war shophouses in Southeast Asia, more than 2,900 within the WHS alone (MPPP, 2008). These shophouses also boast a diversity spanning more than two centuries, manifesting different stages of social background and development. As a result, shophouses in George Town have been studied intensively, the main focus being the ethnicity of façade styles. However, there is a lack of information as well as in depth study on building construction.

1.1 Objective and Rationale
The objective of this research is to collect all available data of shophouse building construction in George Town from a renovation case study, and through the data, observe the characteristics as well as the transition of shophouse building construction. Renovation process provides the opportunity to observe the otherwise hidden details, and thus is a very important source of knowledge in shophouse building construction, which includes construction methods and building materials.

1.2 Research Method
Bibliographic survey of shophouse building construction was carried out from early 2011 and continuously throughout the whole research process. An onsite preliminary investigation of George Town...
was conducted in May 2012. Visual survey of heritage buildings and detailed investigation of eight renovation sites were carried out in July 2012.

Interviews conducted include those with the Municipal Council of Penang Island (MPPP), George Town World Heritage Inc. (GTWHI), conservation NGO Penang Heritage Trust (PHT), architects and project managers involved in shophouse renovation. During the interviews it was learned that there is very limited documentation on pre-war shophouse construction, thus renovation sites are the only primary source of information. Data of the eight renovation cases were collected via interviews, site investigation, client briefing participation and study of renovation documents including drawings, photos and reports.

2. Overview of Shophouses in George Town

Shophouses are low-rise terraced buildings where the commercial activities are on the ground floor and residencies on the upper floor (MPPP, 2008). Shophouses in George Town are divided into six styles depending on their façade design and their construction period (CHAT, 2011). However only general descriptions of building construction (e.g. 'masonry', ‘timber floor’ etc.) are included in style description without specific background and technical details. Moreover, the style classification system focuses on façade details while inner structure is often treated as the same for all the shophouses.

2.1 Management and Renovation

Through interviews it is understood that unlike category I heritage where only restoration work is allowed, all pre-war shophouses fall under category II heritage, where internal alteration and extension at the rear and side are allowed. The renovation guidelines were still under development and were unavailable for public view. Permission from the MPPP is required to perform any form of repair and renovation.

Through interviews it is also learned that the number of shophouse renovation projects is increasing rapidly in recent years especially after WHS listing. Most of them involve adaptive reuse, prompting the local NGOs to raise concern on issues such as insensitive alteration, illegal demolition and rapid change of ownership. One such issue highlighted is swiftlet farming, where shophouses are converted into 'swiftlet houses' so that swiftlets can be bred and their nests farmed. Alterations are done to the shophouses in order to create a warm, dark and humid environment preferred by the birds, which not only jeopardise the authenticity of the shophouses, but also potentially cause structural damage to the buildings through the excessive moisture. There were 173 swiftlet houses as of April 2011 (PHT, 2011).

2.2 Visual Survey and Mapping

A visual survey and mapping of shophouses along nine streets (Fig.4.) were conducted. The results are shown on Table 1. At the time of the survey, 19% of the shophouses surveyed had been renovated recently, and 5% were under renovation, confirming that renovation projects do exist in large numbers, and that this is a reasonable time to conduct a building construction study.

![Fig.2. Façade and Street View of Shophouses in George Town](image)

![Fig.3. Air Well (Left) and Windows (Right) of a Swiftlet House Being Sealed Up and Installed with Pipes as a Bird Entrance](image)

![Fig.4. WHS of George Town, with 3572 Category II Buildings (Mostly Shophouses) in Pink (Map by MPPP, 2008)](image)

| Street name     | Renovated | Under renovation |
|-----------------|-----------|------------------|
| China Street    | 5/76 (7%) | 1/76 (1%)        |
| Macallum Street | 13/65 (20%) | 1/65 (2%)    |
| Malay Street    | 19/80 (23%) | 4/80 (5%)   |
| Muntri Street   | 28/70 (40%) | 2/70 (3%)   |
| Kimberley Street| 10/144 (7%) | 11/144 (8%) |
| Chulia Lane     | 5/38 (13%) | 1/38 (3%)    |
| Armenian Street | 24/73 (33%) | 0/73 (0%)   |
| Carnarvon Lane  | 6/70 (9%)  | 12/70 (17%)  |
| Church Street   | 17/53 (32%) | 1/53 (2%)   |

Streets listed on Table 1
3. Existing Building Construction of Shophouses

Table 2 shows an overview of the eight shophouses selected for this case study. Each construction period is based on interview results and cross-checked with the Kelly Map, a 19th century survey map (GTWHI, 2012). The eight cases could be categorised into two major groups, i.e. 19th century shophouses (A–E) and early 20th century shophouses (F–H). Chapter 3 will discuss the 'existing' building construction observed right before the latest renovation. The results are shown in Figs.6.–10. and 'Existing features' in Fig.11.

| Case | Construction period | Progress as of July 2012 |
|------|----------------------|--------------------------|
| A    | Before 1900          | Under renovation         |
| B    | Before 1900          | To be renovated          |
| C    | 1860s                | Renovated                |
| D    | Before 1900          | Under renovation         |
| E    | 1870s                | Renovated                |
| F    | 1930s                | Renovated                |
| G    | 1930s                | Renovated                |
| H    | After 1900           | Under renovation         |

3.1 Existing Ground Floor

All eight cases had solid ground floors. The concrete beds observed consisted of sand, lime concrete or Portland cement concrete with bricks. Four types of flooring material were observed, i.e. cement finish, terracotta tiles, cement tiles and granite blocks. While cement finish was the most common flooring, in some cases terracotta tiles (2 cases), cement tiles (1 case) and granite blocks (7 cases) were found underneath the cement slab, indicating that cement slabs were added post construction. Through interviews it is understood that most tiles were locally manufactured. Granite from local quarries was used for shophouses, while imported granite was used in more significant buildings such as temples (interview and MPPP, 2008). Tiles and granite were set using lime mortar.
Fig. 11. Building Construction of Shophouses in George Town, Past and Present

| Year | Construction Method | Description |
|------|---------------------|-------------|
| 1957 | Wooden Frame        |             |
| 1980 | Reinforced Concrete |             |
| 2000 | Steel Frame         |             |

Note: The table details the construction methods used in the shophouses over time, from wooden to reinforced concrete, and then to steel frame structures. The diagram provides a timeline and visual representation of these changes, indicating renovation and function changes within the buildings.
3.2 Existing Upper Floor
All cases studied had their upper floors made of hardwood floorboards. The floorboards were tongue and grooved and nailed to the joists. Only native tropical hardwood was used. In five cases, there were cement concrete slabs at the back portion (area beyond the air well e.g. kitchen). They were either added post construction as upper floor extensions or were modified from original terraces. A terracotta-tiled terrace could be observed in case E. The construction of the said terrace, also known as a ‘Madras terrace’, is said to have originated in Chennai (Jenkins, 2011).

3.3 Existing Wall
All cases studied had load bearing brick masonry walls as the main structural component. Clay bricks (7 cases) and cement bricks (2 cases) were observed. The thickness of the party walls ranged between 350 mm – 600 mm for the ground floor and 233 mm – 530 mm for the upper floor. Brickwork without a regular course repetition pattern was observed in all the 19th century cases. Interview with a local architect-cum-heritage expert reveal that it is known as ‘common bond’ and was introduced by the Chinese community. English bond was used for the early 20th century cases. For the 19th century cases, the bricks were thin and were of irregular size, while the bricks found in early 20th century shophouses were larger and more consistent in size. Interview results during site visits suggest that bricks, judging from the wide variety of their sizes, were imported from various places. Nevertheless clay pits and brick kilns were shown on the Kelly Map as well (Brick kiln road, GTWHI 2012). Lime mortar, lime plaster and lime wash were used in all cases while decorative majolica tiles imported from Europe were used as dado tiles in four cases. The lime kiln shown on the 1799 map of George Town suggests that lime was produced locally (Popham, 1799).

4. Transition and Post Construction Changes
In chapter 4, the chronological order of the building construction observed in Chapter 3 is analysed based on the background history of each construction period and happenings at each shophouse that affected the building construction. The result is summarised in the timeline of Fig.11. From the timeline, it is understood that conspicuous changes in building construction took place at the turn of the century with several marked differences that set the late 19th century cases and early 20th century cases apart. This could be observed through building elements that are less likely to be altered post construction, i.e. walls, upper floors and horizontal structural members. For the late 19th century shophouse walls, thin clay bricks with irregular sizes were used. The brickwork was of Chinese origin common bond without a regular course repetition pattern. On the other hand, cement bricks were seen in the early 20th century cases. The bricks also came in thicker and more consistent sizes. Moreover, the brickwork became English bond with a distinguished pattern. RC beams and concrete slabs also began to appear. This suggests that Portland cement and European brickwork were first introduced into the early 20th century shophouses. Decorative elements such as cement tiles and majolica tiles also appeared mostly in the 20th century cases. Through accounts from interviews and bibliographic surveys, these observations could be explained as follows.

4.1 Traditional Materials and Methods
Traditional shophouses were built with materials and methods that suit the hot and humid climate as well as the geographical condition of George Town being
a swampland. Timbers that are susceptible to rot were separated from the ground and supported by clay brick walls. Corresponding to the high water table, lime plaster, lime wash, terracotta tiles and granite were used to enable moisture to escape from the walls and floor. These elements are agreed by local experts to be the traditional materials for shophouses. Interviews and historical accounts suggest that the earliest shophouses in George Town are more Indian influenced, using mostly local materials (CHAT, 2011). From the mid 19th century until the 1910s, Chinese craftsmanship was introduced during the Chinese influx (CHAT, 2011). Together they contributed largely to the construction by introducing vernacular methods and materials such as granite, brickwork and roofing. The British exercised their influence through governance such as town planning, mandatory incorporation of five foot ways (Home, 1997) and the outlawing of thatched roofs in 1887 (MPPP, 2008).

4.2 Westernisation and Modernisation

Accounts of happenings at the turn of century from interviews and bibliographical surveys could be used to explain the change in building construction. There were outbreaks of plague, cholera, malaria, and small pox, which caused the urban planning to be reviewed (MPPP, 2008). An interview with a local historian reveals that a Municipal Ordinance was gazetted in 1887. Before 1900, most buildings were built by artisans and master builders without building plans or technical drawings. The ordinance would empower the council to regulate buildings and the submission of building plans was made mandatory. As a result, the role of designing shophouses shifted to architects recognised by the British while local artisans and master builders without qualifications had to start as draughtsmen. It is possible that during this time the architects chose more standardised brick sizes and brickworks. In Singapore, similar statutory controls were implemented after 1884 (Li, 2007). Furthermore, there was a drastic increase of British architects in Southeast Asia from 1895 to 1910 (Izumida, 2003). New technologies and materials continued to be introduced around this period. Particularly, Portland cement was introduced in the 1880s by British architecture firms (Jenkins, 2011). This brought about the popular use of cement slabs, bricks and RC beams.

4.3 Post Construction Renovations

Post construction alterations were more likely to be observed on non-structural elements i.e. ground floor surface and roofing materials. These alterations are dictated by the popular trend of the period and the workability of new materials and methods. For example, majolica and cement tiles are said to have become popular in the early 20th century (CHAT, 2011). However they were found in case E, a 19th century shophouse, added during the 1924 renovation. Cement concrete floor slabs replaced almost all other flooring types due to flood (e.g. case B) and also the easier and less time consuming application. Similarly, AC sheets replaced terracotta roof tiles in five cases when it became popular in the 1960s. Change of function also entails change in building construction, the example being case A when it was converted into a swiftlet house. Fenestrations were sealed up from within, cement brick swiftlet towers were added and sprinklers were installed to increase the humidity.

5. Changes during Latest Renovation

In chapter 5, the process of the latest renovation is studied, and the impact on building construction is analysed. All cases studied could be interpreted as restorative renovation as traditional features were restored or retained wherever possible, but changes such as additions were also made. The rightmost column of Fig.11. shows the final outcome.

5.1 Restoration

Restoration works mainly involved the ground floor surface and roofing. For example, the six cases with cement ground floor finish were restored back to tiled floors or granite paving. Five cases with AC sheet roofing were restored to terracotta roof tiles.

Fig.13. Restoring the Terracotta Tiled Floor of a Five Foot Way

5.2 Replacement with Similar Materials

Building elements that were retained include tiled floors (3 out of 3 cases) and brick walls (8 out of 8 cases). There are also elements that were mostly retained and only replaced where damaged, including upper floors (6 out of 8 cases), joists (8 out of 8 cases), beams (8 out of 8 cases) and purlins (8 out of 8 cases). Elements that were completely replaced are battens (7 out of 8 cases) and roof tiles (3 out of 3 cases). Non-structural units have a higher replacement rate while only damaged structural units were replaced.

Fig.14. Replacing Hardwood Floorboards

5.3 Reinforcement and Alteration

There were only five examples of reinforcement including the sound proofing of upper floors. The
only large-scale reinforcement was case A's party wall, where the badly inclining wall was reinforced by attaching a RC frame to it. In all cases, minor changes including material size and orientation of unit materials such as granite, bricks and tiles were inevitable. Modern features such as RC and I-beams were introduced into case D, as it was difficult to acquire large timber replacements. In three cases, installation of water closets on the upper floors called for waterproofing treatment by adding layers of Fibre Reinforced Paper or bitumen, lime mortar and terracotta tiles above the hardwood floorboards. In six cases, roof leaks treatment as well as insulation were done by adding aluminium foil and cement boards in between purlins and battens, before laying roof tiles.

5.4 Addition

Five cases involved addition to the back portion of the building, turning the originally one storey into a two-storey structure by attaching RC frames to the existing walls and extending the walls to the upper storey, effectively turning the wall into infill masonry walls. RC grade beams were also added to support the additional load. The addition mainly used traditional building materials while applying new features such as RC frames, Flemish bond, upper floor and terrace reinforcement with metal decking and cement concrete, all of which would not be visible after the finishing.

5.5 Material Supply

Although all eight cases largely made use of traditional materials, the choice is ultimately decided by supply and clients' preference. The origin of new materials remained largely local, although China and Vietnam became the main sources of terracotta products. Recycled materials played an important role in material supply. The term 'recycled' is used locally in the context of 'second-hand goods', which involves only minor reprocessing before being reused. Table 3. shows that almost all building elements made use of recycled materials. Horizontal members in particular used the highest percentage of recycled hardwoods. Interviews with architects and project managers reveal that recycled materials are actively circulated within Penang and even to other regions such as Singapore.

6. Conclusion

George Town has the largest collection of pre-war shophouses in Southeast Asia. The building construction of these shophouses has not been thoroughly recorded and studied due to limited source of information. This paper took advantage of the recent burgeoning of shophouse renovation to study the building construction of shophouses based on observations on eight renovation case studies. Identification of otherwise hidden and unrecorded features, including their dimension, construction and origin of introduction was made possible by observing the existing building construction of eight shophouses. These features exhibit mostly materials and methods introduced by the western, Indian and Chinese communities, but largely make use of easily available local raw materials. This complements the façade styles as a testament to the multicultural aspect of the shophouses, while showing the vernacular nature of shophouses being merchant and labourer oriented where practicality and cost performance precede other

| Table 3. Material Supply in Latest Renovation |
|---------------------------------------------|
| Building material | Use of recycled materials | Origin of new materials |
|-------------------|---------------------------|-------------------------|
| Granite           | 6/6                       | Nil                     |
| Terracotta        | 1/3                       | China, Vietnam          |
| Cement tile       | 3/6                       | Local                   |
| Floorboard        | 4/4                       | Local                   |
| Brick             | 5/5                       | Australia               |
| Majolica tile     | 2/3                       | Nil                     |
| Joist             | 7/8                       | China, Vietnam          |
| Purlin            | 4/8                       | Local                   |
| Batten            | 8/8                       | Local                   |
| Roof tile         | 3/8                       | China, Vietnam          |

Fig.15. Wall Reinforced via RC Frame and Cement Board Added Above the Roof Purlins

Fig.16. Addition of Wall Above the Existing Wall

Fig.17. Recycled Terracotta Roof Tiles
of shophouse building construction, which in turn reveals the development and transition of shophouse construction. Proper and responsible documentation of the renovation process and site surveys should be carried out before the information is lost or overwritten along with the rapid changes. It is also important that future study on building construction should be extended to other cities in Southeast Asia, as this would reveal each city's uniqueness, while at the same time reflecting their interaction.

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Notes

1 'Indian' and 'Chinese' in this paper refer to the Chinese and Indian communities that migrated to Penang during colonial days, while 'Western' refers to the colonial powers especially the British.

2 As shophouse façade styles are frequently explained by other papers, their definition is omitted in this paper. Their detailed information can be found in references 2 and 7.

3 Swiftlets (Aerodramus fuciphagus) are a type of bird whose edible nests are considered a delicacy.

4 'Local' is defined as Penang Island and Province Wellesley.

5 'X out of Y cases' means out of Y cases with existing said feature, X cases had the said feature retained/replaced.

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