

Main Construction Materials used in Malaysian Heritage Buildings

HASNI SURYANI MAT HASAN¹, LILAWATI AB WAHAB¹, DZULKARNAEN ISMAIL¹,
PUTERI ROHANI MEGAT ABDUL RAHIM² AND HASNI SUHANA MAT HASAN³

¹Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, 32610 Perak, MALAYSIA²Academy of Language Studies, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, 32610 Perak, MALAYSIA³General Studies Department, Kolej Poly-Tech MARA Kuantan, 25150 Kuantan, Pahang, MALAYSIA

Abstract: - Malaysia is rich in valuable heritage buildings. Many of the buildings have wonderful traits such as history and culture influences from Europe, Asia, and the Middle East, as well as multicultural architectural legacy and significant Islamic, Chinese, and Western influences. The building materials were enhanced once the nation was colonized. Numerous new building materials were developed and processed in accordance with the suitability of the buildings that were to be constructed at the time. As a result, the heritage buildings are varieties in architecture with different design and materials used. The objective of this study is to identify the main building materials used in the heritage buildings in Malaysia. In order to achieve the objective, document analysis was done. Secondary data was obtained from journal articles of previous researches. It is believed that this study can help organizations or individuals and ease them in conservation of heritage building. Due to the lack of available literature pertinent to building materials used in heritage buildings, this paper provides an update to the literature body by reviewing and discussing the general theories of evaluation. The findings reveals that the main materials used in most heritage buildings in Malaysia are timber, clay and lime plaster. The outcome of the study is hoped to be future reference for the organizations or individuals interested in conservation of heritage buildings.

Key-Words: - Material, Timber, Clay, Limestone, Heritage Building, Malaysia

Received: May 21, 2021. Revised: August 16, 2022. Accepted: September 11, 2022. Published: October 25, 2022.

1 Introduction

In ancient times, many building materials are inherited from natural sources and are readily available in the area surrounding the building to be constructed. Timber, clay and limestone were among the main supplies of building materials used at that period [1]. After the country was colonized, the building materials were improved. Many new building materials were created and processed according to the suitability of the building to be built at that time. For example, clay made of brick and terracotta to be used to build the walls, floors and roofs of heritage buildings. In addition, the stone has also been used as floor finishes such as terrazzo and granite [2]. Furthermore,

Portland cement was introduced as well in 1950 in Malaysia [3]. It is a different choice than the use of limestone plaster. A cement also acts as a binder, a substance that sets, hardens, and adheres to other materials to tie them together for building. Besides, cement combined with fine aggregate creates mortar for masonry, or produces concrete with sand and gravel [4]. Figure 1 shows the main building materials used in heritage buildings. It consists of timber, clay and lime plaster. Further explanation about each material is presented in the next section.

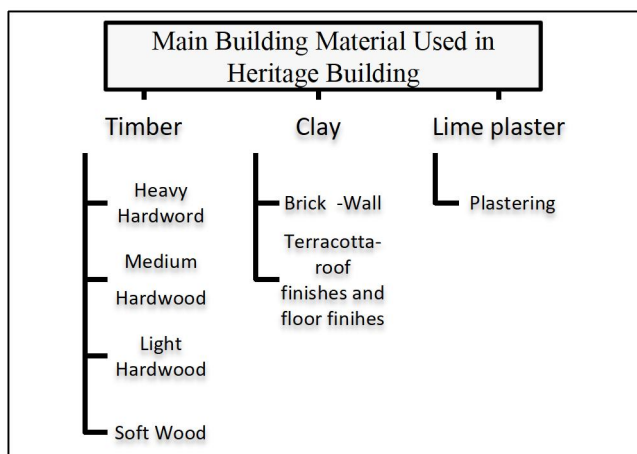


Fig. 1: Main Building Material Used in Heritage Building.

2 Timber

Malaysia is one of the world's leading producers of tropical timber [5]. The design of timber-based buildings has given birth to numerous unique types of building. The art of making beautiful buildings by using timber has been recognized for a long time (Md Ali and Ahmad, 2002). Additionally, timber is a fibrous organic material found in the stems and roots of trees or plants. Usually timber refers to permanent perennial plants. It has been used for thousands of years as a construction material. In conservation work, knowledge of timber is important especially in converting impaired timber to new ones. Replacing timber from a similar form of strength group and species is essential (Ahmad, 2004).

Table 1: Classification of Timber in Malaysia.

Heavy Hardwood	Medium Hardwood	Light Hardwood	Softwoods
1. Balau	1. Alan Batu	1. Acacia	1. Damar mnyak
2. Balau Red	2. Bekak	2. Alan Bunga	2. Podo
3. Belian	3. Derum	3. Ara	3. Sempior
4. Bitis	4. Entapuloh	4. Babai	
5. Chengal	5. Kandis	5. Bavur	
6. Giam	6. Kapur	6. Berangan	
7. Kerani	7. Kasal	7. Bintagor	
8. Melagangai	8. Kayu Malam	8. Binuang	
9. Merbau	9. Kelat	9. Dedali	
10. Nilai	10. Keledang	10. Durian	
11. Pempas	11. Kempas	11. Geronggang	
12. Penyau	12. Keruing	12. Gerutu	
13. Resak	13. Keruntum	13. Jelutong	
14. Selunsur	14. Kulim	14. Jongkong	
15. Tembusu	15. Mata Ulat	15. Kedondong	
	16. Mempeng	16. Kelumpang	
	17. Mengkulang	17. Ketapan	
	18. Meransi	18. Kungkur	
	19. Merawan	19. Laran	
	20. Merbau	20. Machang	
	21. Merpah	21. Mahang	
	22. Mertas	22. Medang	
	23. Nyalin	23. Melantai	
	24. Pauh Kijang	24. Melunak	
	25. Perah	25. Mempisang	
	26. Petaling	26. Meranti Bakau	
	27. Punah	27. Meranti Dark red	
	28. Rengas	28. Meranti Light red	
	29. Rempas	29. Meranti White	
	30. Tampot	30. Meranti Yellow	
	31. Teruntum	31. Merbulan	
	32. Tualang	32. Messava	
		33. Nyatoh	

Sources : George Town World Heritage Incorporated (2016) and Jabatan Perhutanan Semenanjung Malaysia (2020)

There are many classification of timber in Malaysia as shown in Table 1. It consists of heavy hardwood, medium hardwood, light hardwood and softwood. From the list, the most popular timber used in heritage buildings were *Belian, Cengal, Balau, Bitis, Giam, Kempas* and *Meranti* [2], [4], [7], [8]. According to *Jabatan Perhutanan Semenanjung Malaysia (2020)*, timber is naturally solid and can still be used without treatment, and some timber must be treated to increase the quality of the timber before being used in the building.

3 Clay

Apart from timber, clay also contributes to the construction of heritage buildings (*Dalkılıç and Nabikoğlu, 2017; Jabatan Warisan Negara, 2016; Majlis Bandaraya Melaka Bersejarah, 2017*). Clay was used in ancient times to make bricks and finishes. The earliest bricks were simply put in the sunlight for hardening. Sun-dried bricks, during the ancient times were used extensively. The raw clay that was most likely obtained in local clay pits is associated with the building location that was used in construction. The different location of the raw clay pit will change the properties of the clay as this affect the soil types in the region (Canbaz and Albayrak, 2018). Clay is a natural earthy material that is plastic when wet, consisting very fine soil and used for making bricks, terracotta roof tile and terracotta floor finishes in heritage building. In addition, clay is durable and long lasting. It is fire-resistant and able to withstand seismic activity, giving it a possible lifespan of 100 or more years [11].

In Malaysia, as these materials are available in the building area, most of the heritage building finishes consist of handmade clay finishes. The handmade clay finishes are the finishes made by hand or by a hand process. This type of clay finishes is low in density, high in porosity, high in water absorption and low in strength (Lourenço, Fernandes, and Castro, 2010) as this material is only compressed by hand. Furthermore, the size, shape and surface texture were not precise and rough (Suhendra, Handayani, and Revita, 2015). The clay mixtures with water are used to create roof finishes and floor finishes known as terracotta. For example, in Figure 2 it shows the clay used for making terracotta floor finishes.

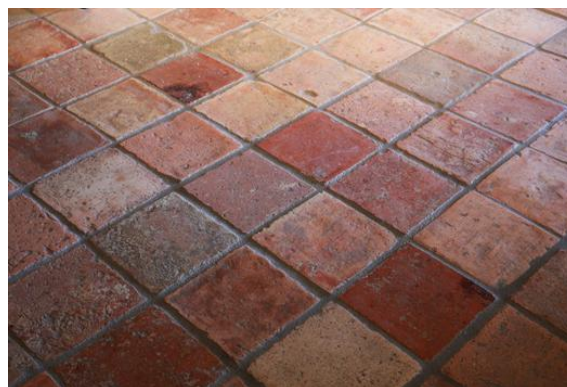


Fig. 2: Terracotta Floor Finishes.

Terracotta is a type of clay that is already formed and fired in low-fired oven. During the firing process, the minerals in the clay give the brick colour as they absorb oxygen. The iron oxide is one of the most important colouring minerals in the clay. This gives the traditional red colour of a brick. Calcareous clay has more lime and gives a yellow colour (Lourenço et al., 2010). A reddish/ brown colour surface roof and floor tile finishes with unglazed surface is widely used in Malaysia (Ibrahim, Harun, and Shamsudin, 2012).

Table 2: Clay Brick Classification and Properties

Clay Brick Classification	Manufacturing	Quality	Texture	Colour
1 st Grade	Machine moulding. Burning with completely without overheating.	High quality Strongest	Smooth surface and consistent Very small particle No crack Precise shape and size.	Dark red, copper
2 nd Grade	Machine moulding. and burning completely with slightly	Stronger	Smooth surface and consistent Small	Dark red, copper

	overheating		crack A minor defect in shape and size	
3 rd Grade	Machine moulding Slightly more or less burnt.	Strong	Smooth surface and not consistent. Defect in shape and size	Red
Handmade clay brick	Hand mould Sun dried or low burnt	Weak Brittle	Rough surface and not consistent. Defect in shape and size.	Yellow to red

Clay is also used to make bricks. Brick is clay-made in the form of a square that was used to build a building's walls. Table 2 shows the clay brick classification and properties. It consists of manufacturing process, the clay brick quality, texture and colour of clay brick. Figure 3 shows the different sizes of handmade clay used in heritage building. In addition, clay bricks were used for exterior and interior walls, partitions, piers, bases and other load-bearing structures [14]. According to Kelly and Ward (2020), clay brick was one of the oldest building materials used by man, dating back more than 5000 years ago to the days of the Babylonians. It is also one of the most commonly used construction materials due to its resilience, structural capability, energy efficiency and environmental impacts.



Fig. 3 Different Size of Handmade Clay Used in Heritage Building.

Sources : George Town World Heritage Incorporated (2016)

4 Lime Plaster

Other than the above mentioned material, lime plaster also was used in the making of heritage building in that era. The standard finish for pre-1919 houses is lime plaster, but it may have been used until the 1950s, when plasterboard, gypsum and Portland cement took over. Lime plaster is a type of plaster composed of sand, water, and lime, usually non-hydraulic hydrated lime [17], [18]. Besides, lime plaster is smoother than cement-filled modern plaster and hardens much slower than cement, making it much more workable. This material is also less porous and less susceptible to cracking, and any cracked area will absorb and reduce carbon dioxide over time. Modern plasters, on the other hand, harden very easily, but may be too solid for certain uses, such as working with old bricks (Mat Radzuan, Mohammed Ishaq, Sulaiman, and Ahmad, 2017). Lime plaster is used for coating walls and helps buildings to breathe by moisture evaporating through mortar joint as shown in Figure 4. This was to maintain structural integrity and protect historic buildings with the elimination of moisture forms [20].

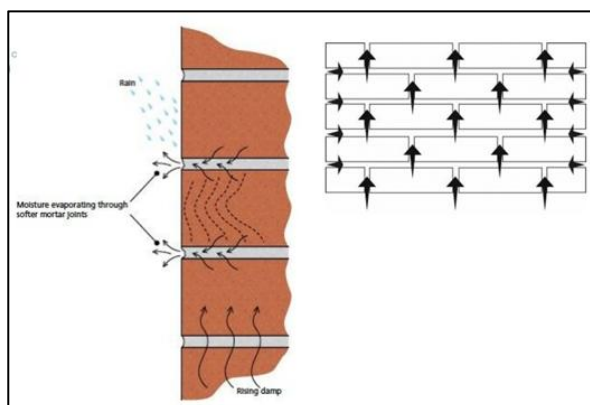


Fig. 4: Function of Lime Plaster in Heritage Building Wall.

Sources :George Town World Heritage Incorporated (2012b)

5. Research Method

To obtain the objective, document analysis was done using previous researches and local authority guidelines. Thus, only the main building materials were selected for analysis in this study. The reason behind this data collection was to extract only the main building materials listed under the guidelines since these building materials usually experience decay and change in conservation works. Therefore, the documents involved in this study include George Town World Heritage Site Special Area Plan, Special Area Plan: Malacca Historical City in Strait of Malacca, Special Plan of Ipoh Town Area 2020 and Malaysia National Heritage: Guidelines on Heritage Building Conservation.

6 Conclusion

In conclusion, most of the construction materials used to build the heritage buildings consist of those sources from natural materials, environmentally friendly and easy to find in building surrounding areas such as timber and clay. Besides, in those days, the manufacture and method of shaping and process building materials were as easy as using hands. Hence, the authenticity of the material is the most important aspect of conserving the authenticity of the heritage building. The material is considered an important value in a building because it contains evidence of knowledge, idea and skill in the process of making the material that has been diminished as well as the recognition of the former glory of the building at that time.

Due to that, it is important to choose what era the buildings were built and how they should be preserved. Thus, there is a need to study the buildings' era prudently. For conservation design as aptly put by Martins, Forbes, Pereira, and Matos at 7th International Conference on Building Resilience in 2018, it is necessary to study the structure of the original building, architectural style, and building relationships with the environment to ensure the heritage building is preserved.

References:

- [1] Jabatan Warisan Negara, *Garis Panduan Pemuliharaan Bangunan Warisan*. Kuala Lumpur: Kementerian Pelancongan dan Kebudayaan Malaysia, 2017.
- [2] Majlis Bandaraya Melaka Bersejarah, *Rancangan Kawasan Khas: Melaka Bandar Bersejarah di Selat Melaka*. Melaka: Majlis Bandaraya Melaka Bersejarah, 2017.
- [3] M. Z. Sulieman, "Prestasi Mortar Terubahsuai Polimer dalam Ferosimen .," Universiti Sains Malaysia, 2004.
- [4] George Town World Heritage Incorporated, "George Town World Heritage Site Special Area Plan," Pulau Pinang, 2016.
- [5] Jabatan Perangkaan Malaysia, "Malaysia Trade Statistics," Kuala Lumpur, 2020.
- [6] M. F. Ahmad, *Kajian Kesan Keratan Rentas Terhadap Pengecutan Struktur Kayu*. Pulau Pinang: Pusat Pengajian Kejuruteraan Awam, Universiti Sains Malaysia, 2004.
- [7] Jabatan Warisan Negara, *Garis Panduan Pemuliharaan Bangunan Warisan*. Kuala Lumpur: Kementerian Pelancongan dan Kebudayaan Malaysia, 2016.
- [8] Jabatan Perancangan Bandar dan Desa Negeri Perak, *Rancangan Kawasan Khas Ipoh 2020*. Perak, 2014.
- [9] N. Dalkılıç and A. Nabikoğlu, "Traditional Manufacturing of Clay Brick Used in the Historical Buildings of Diyarbakir (Turkey)," *Front. Archit. Res.*, vol. 6, no. 3, pp. 346–359, 2017.
- [10] M. Canbaz and U. Albayrak, "Properties of Ancient Style Handmade Clay Bricks Using Bottom Ash," *Anadolu Univ. J. Sci. Technol. - Appl. Sci. Eng.*, vol. 19, no. 1, pp. 1–1, 2018, doi: 10.18038/aubtda.332855.
- [11] A. Muhamad, "Seramik Purba yang Diperdagangkan di Semenanjung Malaysia," *Sari J. Alam dan Tamadun Melayu*, vol. 28, no. 1, pp. 3–40, 2010.
- [12] P. B. Lourenço, F. M. Fernandes, and F. Castro, "Handmade Clay Bricks: Chemical, Physical and Mechanical Properties," *Int. J. Archit. Herit.*, vol. 4, no. 1, pp. 38–58, 2010.
- [13] Suhendra, E. Handayani, and M. Revita, "Karakteristik Fisik Bata Merah dan Kaitannya dengan Analisa Harga Satuan Pekerjaan.," *J. Ilm. Univ. Batanghari Jambi*, vol. 15, no. 4, pp. 158–163, 2015.
- [14] J. W. P. Campbell, *Brick: A World History*. London: Thames & Hudson, 2016.
- [15] P. Kelly and T. Ward, "Green Benefits of Clay Brick," *Hanley Wood Media Inc*, 2020. .
- [16] Jabatan Perhutanan Semenanjung Malaysia, "Harga Kayu Balak," *Jabatan Perhutanan Semenanjung Malaysia*, 2020. .
- [17] Badan Warisan Heritage Services Sdn Bhd, *Historic City of George Town Heritage Management Plan State Government of Penang*. Kuala Lumpur: Badan Warisan Heritage Services Sdn Bhd, 2008.
- [18] S. Dai, "Building limes for cultural heritage conservation in China," *Herit. Sci.*, vol. 1, no. 1, p. 25, 2013, doi: 10.1186/2050-7445-1-25.
- [19] I. S. Mat Radzuan, M. Mohammed Ishaq, N. Sulaiman, and Y. Ahmad, "Conserving the Heritage Village in Malaysia: Perspective and Challenges," in *Safeguarding Cultural Heritage: Challenges and Approaches . E-Proceeding of the 2nd International Nusantara Cultural Heritage Symposium 2017*, 2017, pp. 116–120.
- [20] G. Allen, *Hydraulic Lime Mortar for Stone, Brick and Block Masonry: A Best Practice Guide*. New York: Routledge, 2015.
- [21] George Town World Heritage Incorporated, *Pengenalan Bahan-Bahan Bangunan Warisan*. Penang: George Town World Heritage Incorporated, 2012.
- [22] A. N. Martins, C. Forbes, A. A. Pereira, and D. Matos, "The Changing City: Risk and Built Heritage. The Case of Lisbon Downtown," in *7th International Conference on Building Resilience; Using Scientific Knowledge to Inform Policy and Practice in Disaster Risk Reduction*, 2018, vol. 212, pp. 921–928.