

# **Of Brick and 'Chuna': Technological Tradition and Innovation at Fort Cornwallis, Penang, Malaysia**

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**Association for North American  
Graduate Programs in Conservation**  
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# INTRODUCTION – THE STRAIT OF MALACCA



**Figure 01:** The Strait of Malacca by Natural Earth, US. Energy Information Administration. Retrieved from Bloomberg News, 2019



**Figure 02:** Penang Island. Red dot indicates Fort Cornwallis. Retrieved from OpenStreetMap, 2025



# INTRODUCTION – FORT CORNWALLIS



**Figure 03:** Aerial view of Fort Cornwallis  
Image by Think City, 2024



**Figure 04:** Fort Cornwallis powder Magazine, circa 1813.  
Image by Think City, 2024



## RESEARCH PROBLEM

This research examines if and how 19th-century British fortification building technology, and specifically powder magazines construction technology, was adapted to the tropical environments of their colonial settings in Southeast Asia.



Figure 05: Powder Magazine at Southwest bastion by Daniel Saldaña, 2024





## RESEARCH PROBLEM

### SUBPROBLEMS

**Understand** the social interactions between the different populations involved in the design and construction of colonial buildings

**Understand** the architectural design and expected performance of powder magazines in relation to a British Colonial tropical setting

**Identify** traditional local and/or imported materials utilized for British Colonial construction in early Penang

### DELIMITATIONS

- Early Penang (1786-1846) - Malaysian architectural historian Jon Sun Hock Lim
- No Condition assessment
- It will not delve into the broader social and political implications of British Colonialism
- Material sampling limited to the magazine walls and the adjacent bastion wall
- Material analysis focused on the exterior architectural finishes (render/stucco) of the Powder Magazine





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**1. SOCIAL:** The builders of Early Penang



**2. ARCHITECTURE:** Powder magazines and the built environment of Early Penang



**3. MATERIALS:** Construction and render technology in Early Penang





## 1. SOCIAL

### The builders of Early Penang

**Figure 06:** Stevedores in front of Fort Cornwallis. Photo by Feilberg, 1867.



# KEY PLAYERS IN THE CONSTRUCTION OF COLONIAL PENANG

## BRITISH ENGINEERS



- Trained in England Military Academies
- Previous construction experience in India
- Superintendent Engineers in charge of designing, constructing and planning the settlement
- Dependence on historic treatises, local construction knowledge and local workforce

**Figure 07:** Field officer of the Royal Engineers. Aquatint by Smith, 1812



# KEY PLAYERS IN THE CONSTRUCTION OF COLONIAL PENANG

## CHINESE COMMUNITIES – MERCHANTS AND CONTRACTORS



- Participation in building trades
- Regional trading networks
- Extraction of raw materials, manufacturing, and logistics for construction
- Circulation of supplies and workforce
- Won public construction bids

**Figure 08:** Chinese merchants in Penang.  
Photo by Taylor, 1881



# KEY PLAYERS IN THE CONSTRUCTION OF COLONIAL PENANG

## INDIAN AND MALAY COMMUNITIES



- Participation in building trades
- Previous experience with British engineers
- Military personal and sailors – “Sepoys” and “lascars”
- Penal and Indentured labor

**Figure 09:** Man from Madras in Penang.  
Photo by Feilberg, 1867



# WHO BUILT THE POWDER MAGAZINE?

**DESIGNER:** Thomas Anburey, Superintendent Engineer (Bengal Corps)

## ESTABLISHMENT OF ARTIFICERS



**Figure 10:** Indentured labor building public projects supervised by an overseer in Penang. Photo by Feilberg, 1867

## CHINESE CONTRACTOR(S)



and/or

**Figure 11:** Chinese workers. Photo by Feilberg, 1867 and watercolor by Thomson, 1879





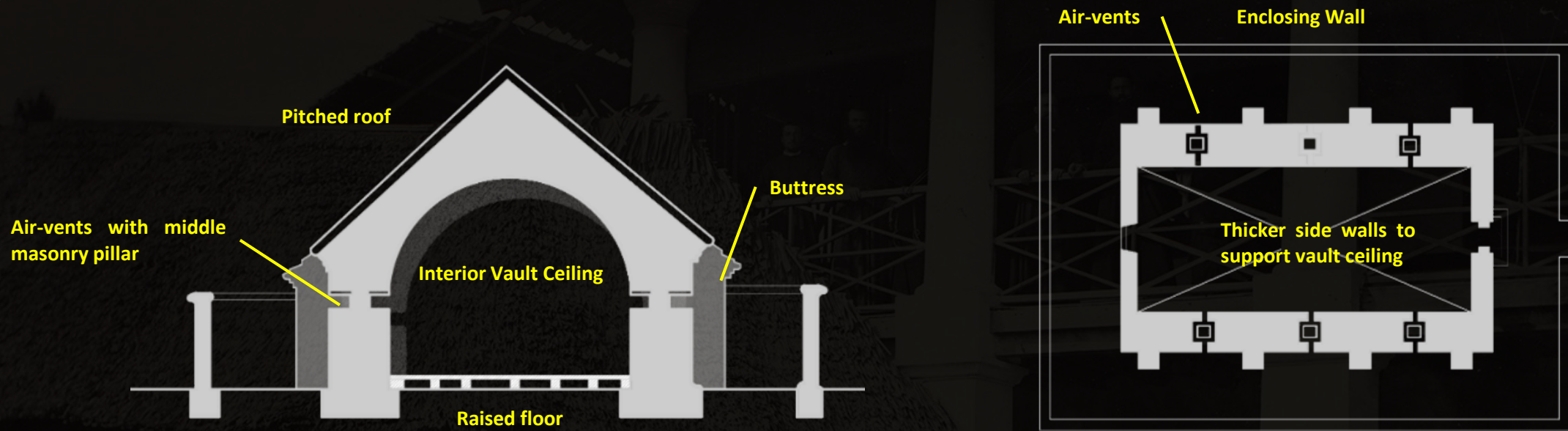
## 2. ARCHITECTURE

The built environment of  
Early Penang

**Figure 12:** Coexistence of different construction methods in a Christian mission. Photo by Feilberg, 1869



# POWDER MAGAZINES ON HISTORIC TREATISES



**Figure 13:** Section and plan of a powder magazine prototype by Vauban in 1693. Drawings by Angela Anchante, 2025



**Figure 14:** Upnor Magazine in England with semicircular arches, 1812. Drawings by Angela Anchante, 2025



## BUILT ENVIRONMENT OF EARLY PENANG



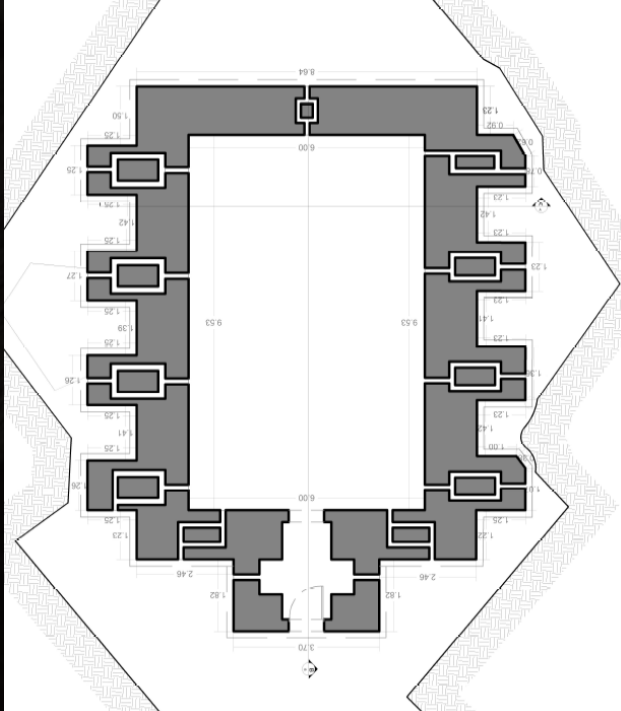
**Figure 15:** Suffolk House at Prince of Wales Island in 1818. Retrieved from the Penang State Museum, 2023



**Figure 16:** Christian missions showing classical columns, tiled and thatched roofs in Penang. Photo by Feilberg, 1867.



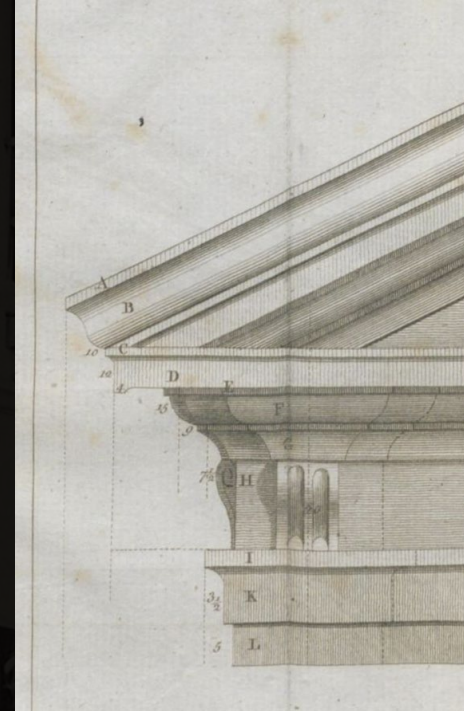
# THE ARCHITECTURE OF THE POWDER MAGAZINE



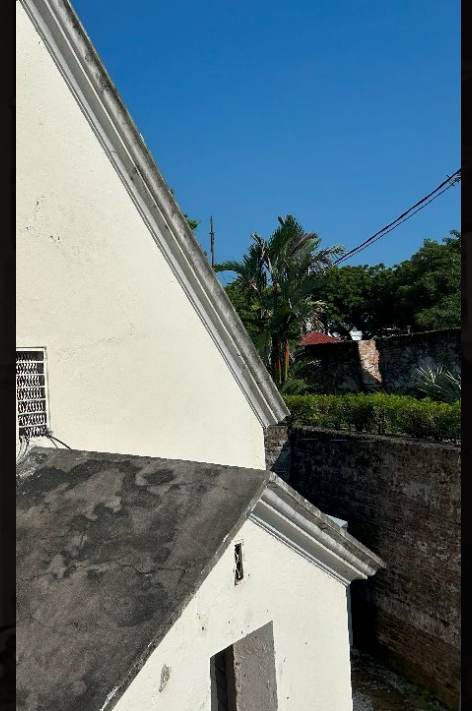
**Figure 17:** Ventilation managements within the magazine.  
Figure by author, 2025.



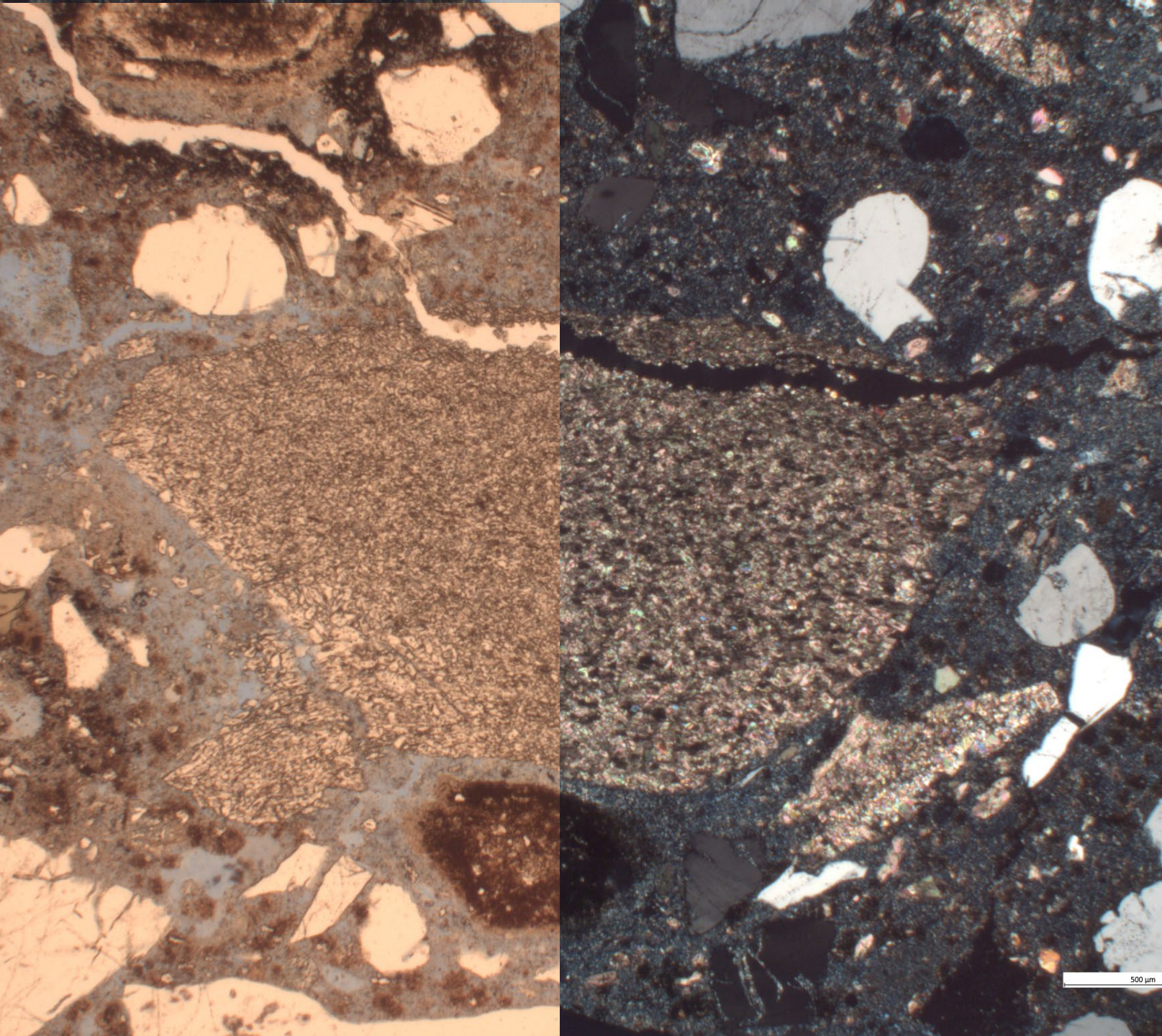
**Figure 18:** Runoff water management system within the bastion.  
Figure by author, 2025.



**Figure 19:** Comparison of magazine's Tuscan cornice with a William Pain's treatise plate.  
Figures by Pain, 1785







### 3. MATERIALS

Construction materials  
and render technology of  
Early Penang

**Figure 20:** PPL/XPL views of calcium carbonates on thin sections from samples. Figures by author, 2025.



# DATA AND METHODOLOGY

## Traditional Construction Materials

Interviews + Previous restoration campaigns

Exposure Windows

Sampling

Stereomicroscopy / Cross Section Analysis

Petrographic Analysis

Instrumental Analysis

## Popular Construction Materials

- Bricks
- “Chuna” or “chunam” – limestones, seashells or corals
- Sugar jaggery for workability purposes



**Figure 21:** Construction of a shophouse in Penang. Wooden scaffolding and plastering of exterior surfaces.

Photo by Feilberg, 1869



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**Figure 22:** Removal of plaster during the 2000 Restoration campaign.  
Figure by Ghafar, 2000.



## DATA AND METHODOLOGY

Traditional Construction Materials

Interviews + Previous restoration campaigns

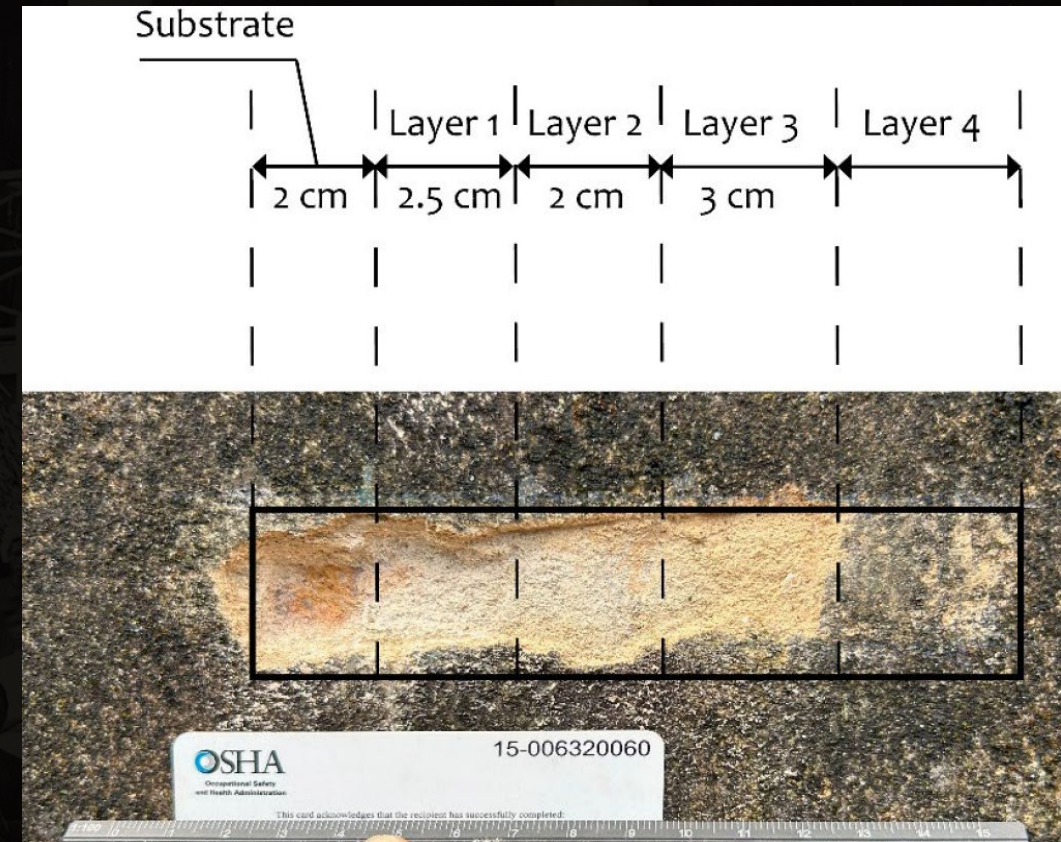
Exposure Windows

Sampling

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Petrographic Analysis

Instrumental Analysis



**Figure 23:** One of the 11 Exposure window. Buttress wall. Brick and mortar substrate, 3 main layers and surface. Figure by author, 2025.



# DATA AND METHODOLOGY

Traditional Construction Materials

Interviews + Previous restoration campaigns

Exposure Windows

Sampling

Stereomicroscopy / Cross Section Analysis

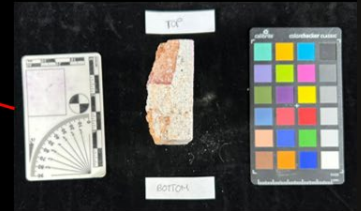
Petrographic Analysis

Instrumental Analysis

SA.FC.PM.01



SA.FC.BA.01



**Figure 24:** 3 samples extracted: Magazine buttress (2) and bastion wall (1).  
Figure by author, 2025.



## DATA AND METHODOLOGY

Traditional Construction Materials

Interviews + Previous restoration campaigns

Exposure Windows

Sampling

Stereomicroscopy / Cross Section Analysis

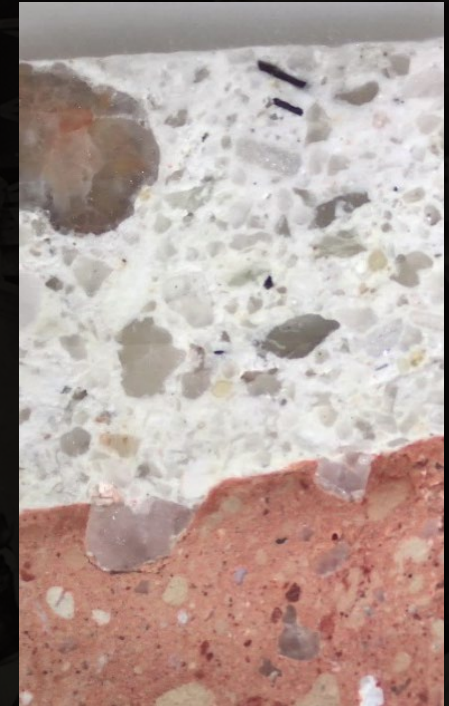
Petrographic Analysis

Instrumental Analysis

XS.FC.PM.02



XS.FC.BA.01



**Figure 25:** Cross sections of samples extracted showing a mono and multilayer render distribution. Figure by author, 2025.



## DATA AND METHODOLOGY

Traditional Construction Materials

Interviews + Previous restoration campaigns

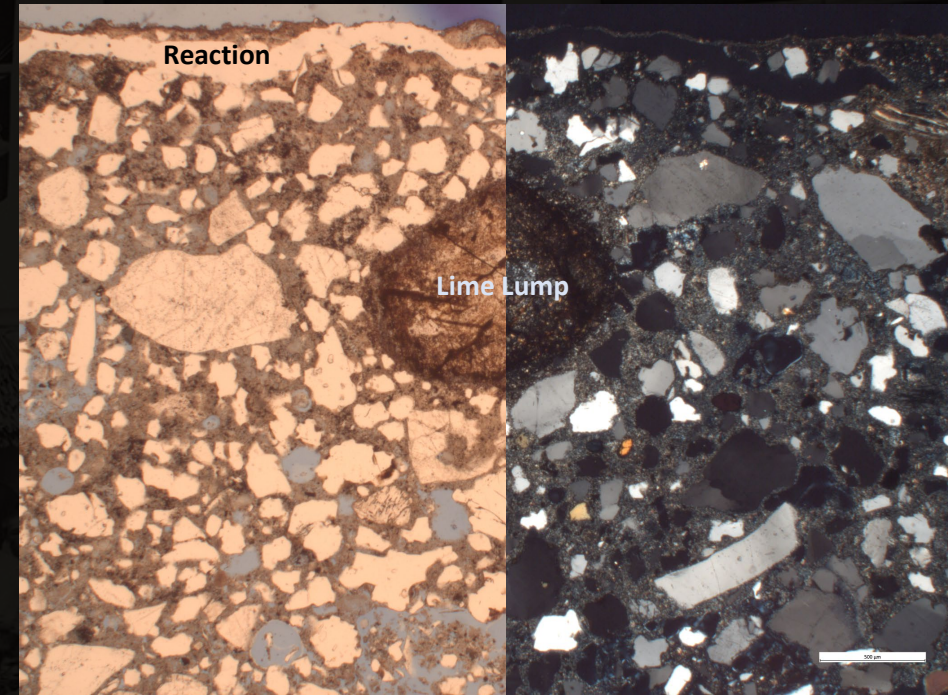
Exposure Windows

Sampling

Stereomicroscopy / Cross Section Analysis

Petrographic Analysis

Instrumental Analysis



**Figure 26:** PPL/XPL microphotographs of top layer. See Lime lump and surface-parallel reaction.  
Figure by author, 2025.



# DATA AND METHODOLOGY

Traditional Construction Materials

Interviews + Previous restoration campaigns

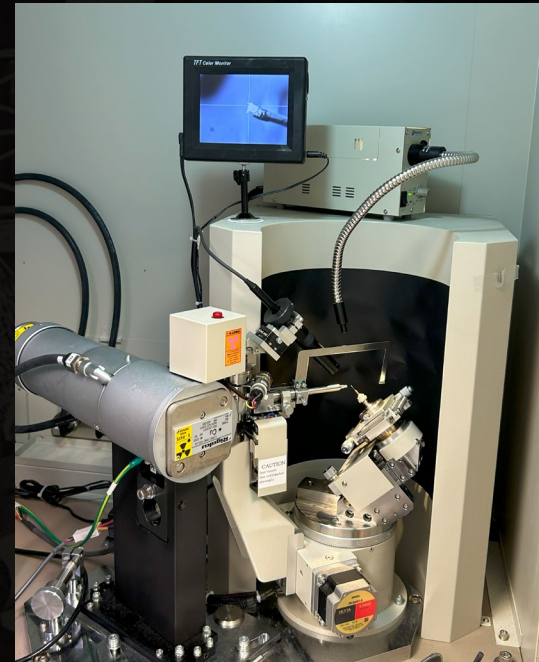
Exposure Windows

Sampling

Stereomicroscopy / Cross Section Analysis

Petrographic Analysis

Instrumental Analysis



**Figure 27:** Diffractometer and powdering of samples.  
Figure by author, 2025.



# RESULTS AND INTERPRETATION

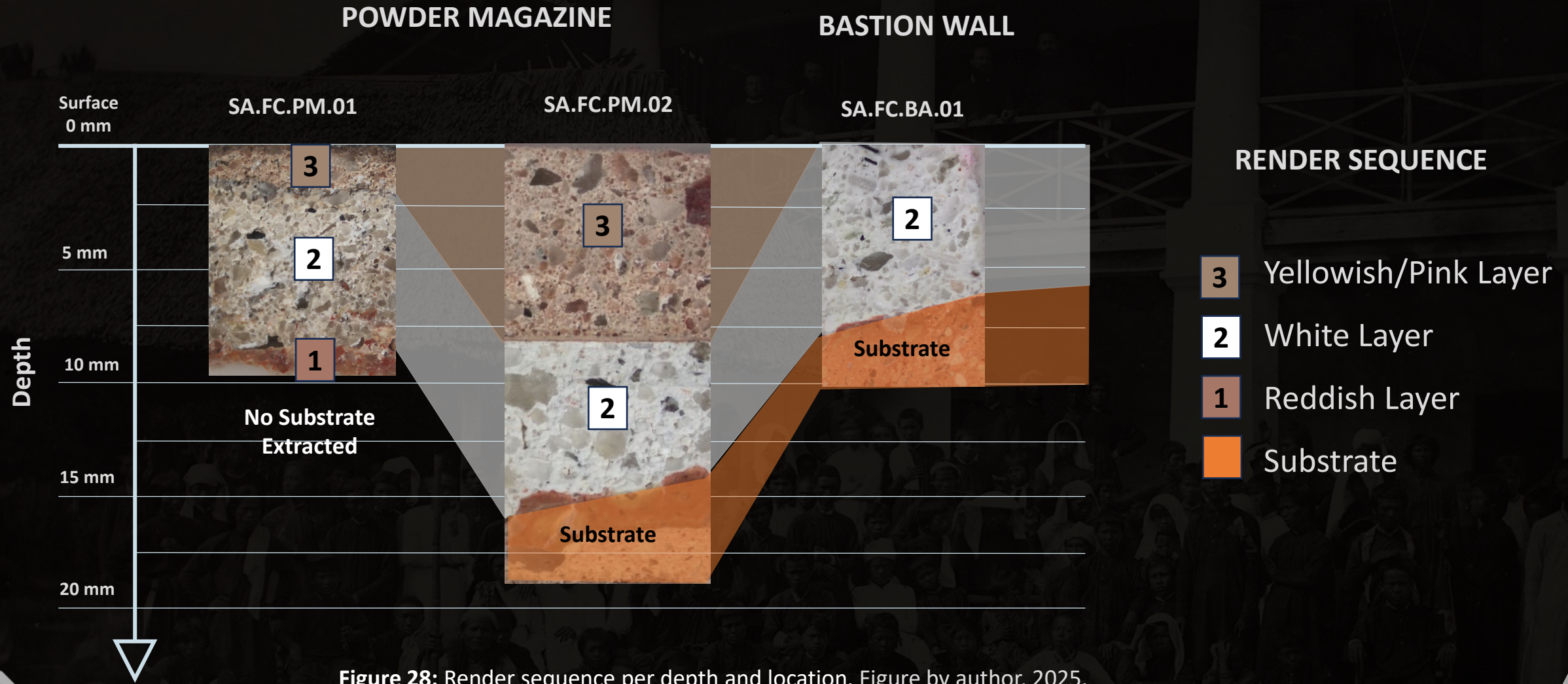


Figure 28: Render sequence per depth and location. Figure by author, 2025.





## CONCLUSIONS

**Figure 29:** 3D Scanning of powder magazine. Figure by author and Angela Anchante, 2025.





## CONCLUSIONS

### PERSPECTIVES

**SOCIAL:** The builders of Early Penang



Multicultural construction environment,  
diverse crews involved in the project

**ARCHITECTURE:** Powder magazines and  
the built environment of Early Penang



Design adjustments of the prototypical  
design for powder magazine to efficiently  
manage rainwater

**MATERIALS:** Construction and render  
technology in Early Penang



Use of limestone and techniques to make  
the render whiter, architectural purposes.  
No organic additives detected.



Thanks for you attention! Questions?



**Figure 19:** 2024 Summer Internship Team in Penang (UPenn, Think City Malaysia and the Aga Khan Trust for Culture). From left to right: Najihah Mohd Sobri, Nour Jafar, Giovanni Santo, Francesco Siravo, Sallishah Ali and Daniel Saldana.

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