



Chapter 22

Interior Polychromy and Wall Paintings in Khmer Brick Temples of the 9th and 10th Century in Cambodia

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Abstract

During research activities and conservation interventions on Khmer brick temples, traces of decorative paintings and polychromy have been discovered in the interior of the Prasats. A broad assessment in 19 selected brick temples of the 9th and 10th century AD has revealed that the inside was originally covered with wall paintings or polychromic decoration. This paper presents an overview of the different decoration systems derived from evidence found in the temples. The investigation focused primarily on the documentation of the important ornamental and figurative wall paintings in the temples Preah Ko in Rolous, Prasat Thom in Koh Ker and Prasat Neang Khmau in Takeo Province. Painting techniques were studied in detail and materials analyzed. Some of the decorative patterns were visualized by virtual reconstruction using forms from the stucco and stone ornaments of the outer decoration as a guide. These findings contribute to a deeper understanding of Khmer art.

Introduction

The restoration of Khmer temples in Cambodia has focused mainly on the preservation of building structures. Little attention is paid to the architectural polychromy inside the tower shrines of the ancient Khmer Empire. It seems unlikely that the Khmer artists, usually attentive to detail, left the interior of the towers as bare brick walls, especially considering their use as a sacred place for worshipping. Remains of painted wall decoration in two temples showing both ornamental and figurative painting have been described but not investigated, by Henri Parmentier (1913) and Rodolfo Lujan Lunsford (1996a: 41). During the conservation work of the German Apsara Conservation Project (GACP), plaster and paint were discovered in several brick towers as well as in stone buildings (Kiesewetter *et al.* 2002; Plehwe-Leisen and Leisen 2005, 2008). This required an evaluation of the brick temples in order to compile an inventory of the interior decoration and the painting materials and techniques used. The investigation involved a comprehensive examination of 19 selected brick temples with 105 brick towers, and proved for the first time that the insides of Khmer brick temples were originally decorated with wall paintings and polychromy.

Assessment Methodology

The scope of work for this assessment was to reveal whether the Khmer brick shrines were, in general, decorated with wall paintings. Specific temples in three regions were chosen for investigation [Fig. 22.1]. In Angkor Park, including the Rolous region, the temples Ak Yum, Prei Monti, Preah Ko, Bakong, Lolei, Phnom Bakheng, Prasat Kravan, East Mebon, Pre Rup and Baksei Chamkrong were included in the survey. This selection covered almost all important brick temples in Angkor. In the area of Koh Ker, eight temples were examined, namely the brick temples Prasat Thom, Prasat Chen, Prasat Pram, Prasat Damrei,



Fig. 22.1: Map showing the investigated temple areas (bold) in Cambodia (Drawing: Daniel Dalet / d-maps.com).

Prasat Pi Chean, Prasat Chinres, Prasat Kraham and Prasat Krachap. Furthermore, the temple Prasat Neang Khmau south of the capital Phnom Penh was included in the study because of the significance of its known figurative paintings. Chronologically these selected temples cover a range of about 150 years and are all assigned to the Angkor era (9th–15th century AD).

The field survey followed a methodology exclusively developed by the authors in order to gain all necessary information. Preserved tower shrines were recorded on the existing ground plans. A schematic elevation of the walls provided a basis for recording the preserved remains of painted wall decoration and places of sampling. In Preah Ko, Prasat Neang Khmau and Prasat Thom, additional video microscopy and band pass-filter reflectography with special filter and image processing techniques were used to explicitly record the remaining details of the wall paintings.

Samples were investigated in the laboratories of the University of Applied Sciences Cologne. Cross-sections of the samples were prepared and studied. The composition of the wall paintings and the paint layers themselves, the identification of dirt deposits, salt crusts and microbiological colonization were examined. Mixtures of pigments of the paint layers were described, and the thickness and grain-size distribution measured. Samples from heavily soiled surface areas were taken in order to search for invisible paint layers underneath.

The painting materials were examined with polarizing microscopy and digital video microscopy, Fourier Transform Infrared (FT-IR) Spectroscopy, Scanning Electron Microscopy-Energy Dispersive X-ray (SEM-EDX) analysis, X-ray Diffraction (XRD) analysis and Visible (VIS) Spectrometry. Additionally, fluorescence microscopy was applied to selected samples where residue of organic compounds, i.e. binding medium, had been detected.

Objects of Investigation

In 1992, the territory “Archaeological Park of Angkor” — Angkor, Banteay Srei and Rolous — was added to the UNESCO World Cultural Heritage list. It covers a total area of 401km² and contains an extraordinarily high number of temples that have been erected in honor of Hindu deities. In Angkor, the capital of the Khmer Kingdom, the most and greatest construction activities took place between the 9th and 13th centuries AD. However, the temples of the Khmer are scattered throughout the country. Another important area is Koh Ker from the 10th century AD. It covers an area of 35km², located approximately 120km northeast of Angkor in the province of Preah Vihear.

The Khmer temples comprise an area where several towers, galleries and platforms rise to a complete architectural complex. Each temple is generally surrounded by an enclosure or moat. Sandstone, brick and laterite towers can be found side by side in one temple complex, as in Bakong, with its younger main tower erected with sandstone, while the towers at the foot of the pyramid consist of brick. The number of brick towers of a temple complex varies according to the individual ground plan. Baksei Chamkrong shows just one single tower on the top of the pyramid tower, Pre Rup and East Mebon possess one main tower and four minor towers in the corners of the platform in the quincunx arrangement. Bakong and Bakheng include a multitude of brick towers surrounding the pyramid. Brick constructions belong to the earlier Angkor period. In the later Angkor period the temples are mostly constructed of sandstone.

As most of the 19 temple complexes investigated include several brick towers, the total quantity of examined brick towers add up to 105. Three temples have figurative or ornamental decoration and were therefore chosen as main sites: Preah Ko (Rolous), Prasat Thom (Koh Ker) and Prasat Neang Khmau (Takeo).

Evidence of polychromy was discovered in 43 brick towers. But the state of preservation of the paint is mostly very poor. It is highly dependent on the state of deterioration of the tower itself, which varies to a great extent.

The Khmer construction technique with deficient bonding of masonry and insufficient foundation as well as the overgrowth of the structures by vegetation, result in an extreme state of static decay of the buildings. Due to the damage in the structure of the towers themselves, many wall paintings are exposed to weathering, particularly to high water infiltration during monsoon rains, and are in imminent danger of loss.

The Decoration of Brick Towers

The wall decorations inside the brick towers can be divided into different systems. The three main objects have been studied in detail with comprehensive technical examinations and recording of their condition. Here, a specific approach to conservation proposals has been established.

Classification of Decoration Systems

The discovered wall decoration remains can be classified into five decorative systems [Table 22.1]. The walls carry a monochrome wall coloring either in light red or yellowish brown imitating the brick color, or in darker red. On the monochrome walls different decoration features can be found. They can be accentuated in the dado area or the area below and on the cornice.

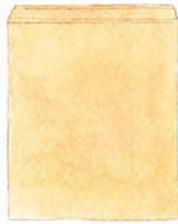
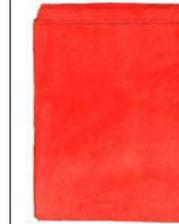
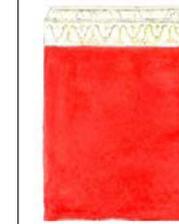
Due to the poor preservation state of the wall coloring, evidence was not found in all of the towers of one complex. However the principle of symmetry and repetition in Khmer art allows one to assume that evidence found within individual towers would likely be found in others in the same temple complex.

Technical Examination

Preparation

The preparation of the walls depends on the decoration concept. Brick-colored wall colorings were applied directly on the brick surface. More saturated red wall paints were put on a preparation layer of wash to

Table 22.1: The decoration systems in Khmer brick temples

System	1 light red / brick colored	2 light red / brick colored, red decoration lines	3 light red / brick colored, black decoration line and red dado	4 red	5 figurative / ornamental
Temple	Lolei (AD 893) Prasat Damrei (AD 921–944) Prasat Chinres (AD 921–944) Baksei Chamkrong (AD 968)	Pre Rup (AD 961)	East Mebon (AD 953)	Bakong (AD 881) Phnom Bakheng (ca. AD 900) Prasat Kravan (AD 921) Prasat Pram (AD 921–944)	Preah Ko (AD 879) Prasat Thom (AD 921–944) Prasat Neang Khmau (AD 933–928)
Example					

even out the wall surface. These walls were left as bare red walls, like for example at Phnom Bakheng (white preparation layer) or Bakong (dark brown preparation layer). In contrast, the red coloring on walls with ornamental decoration serves as a preparation layer for the ornaments and is not provided with an underlying layer.

Several paint layers show a clearly identifiable brush flow. This demonstrates that the paint layers were applied as a wash, and not as plaster.

Pigments

The optical assessment of the surface on site and of the samples and the cross sections in the lab revealed the original color and the composition of the paint layers. The prepared cross-sections of the samples were examined optically with polarized light microscopy, which provides information about the morphology of the grains of pigments (homogeneity, size, form), including the aggregation state and optical characteristics. With this first overview on the bulk samples taken, representative samples could be selected for further investigation into the painting materials used.

In selected cross-sections the chemical composition of the pigments was analyzed by SEM-EDX. FT-IR and XRD analysis was used to clarify the mineral composition of the pigments. A compilation of the identified pigments, their use on the object and methods applied for the analysis is given in Table 22.2.

The red pigments of the samples were identified as clay pigments, i.e., aluminum silicates with iron oxides as colorant. An exception is found in one sample of the figurative painting of the central porch of Prasat Thom, where cinnabar was identified by using the VIS spectrometer and confirmed by the detection of mercury by SEM-EDX analysis. Whether it is a naturally occurring mineral or manufactured, cinnabar is hard to distinguish by microscopy. The synthetic preparation of cinnabar by dry sublimation of sulphur and mercury has been known since the 4th century AD (Garner 1963: 84–5), thus the Khmer might have been familiar with this technique.

The pigments of the black paint are also aluminum silicates, here with manganese and iron oxides as coloring components. Samples of white paint layers also show the use of clay pigments identified as kaolin. It is the preferred white pigment in the Asian region (Hradil *et al.* 2003: 224).

The analyses revealed that the colorants in the bright red, brick-colored paint seem to be the same as in the darker red coloring. No indication was given as whether a light red clay or brick dust was used. Both colorants are derived from the same raw materials, and “burnt ochre”, which in chemical terms corresponds to bricks, is hard to distinguish from the natural clay pigments. Yellow pigments were not

Table 22.2: Summary of the pigment analyses

Color	Samples	Appearance	Analyzed pigment	Investigation method
red	13	wall color decoration line ornament	red ochre	PLM, SEM-EDX, FT-IR
red	1	figurative painting (Prasat Thom)	vermilion	PLM, VIS, SEM-EDX
light red	2	wall color	light ochre / brick dust	PLM, SEM-EDX, FT-IR
black	6	decoration line	black iron oxide ornament	PLM, SEM-EDX, FT-IR, XRD
white	3	ornament figurative painting	kaolinite	PLM, SEM-EDX, FT-IR, XRD

Notes: PLM = Polarized light microscopy
SEM-EDX = Scanning Electron Microscopy-Energy Dispersive X-ray analysis
FT-IR = Fourier Transform Infrared Spectroscopy
VIS = Visible Spectroscopy, XRD = X-ray-Diffraction

separately investigated because they are only present as a blending in the white paint layers, but it is most likely that ochre pigments were used. The use of clay pigments from the iron-rich soils of Cambodia is self-evident.

Binding Medium

The FT-IR analysis clearly excludes the use of calcium carbonate as a binding medium for the wall paintings. In none of the 25 investigated samples were the peaks of CaCO_3 at 1435 and 875 and 715 cm^{-1} detected in the spectrums. If lime had been used as a binder, these bands would be distinctive even after a long period of weathering. Evidence of organic compounds in the binding medium were found by the FT-IR spectrum of the red paint of Bakong and the black paint layer of Prasat Thom. The FT-IR spectrum of the sample from the red wall paint at Bakong with peaks at 2926 cm^{-1} and 2860 cm^{-1} indicates the presence of alkyl chains. The intensely strong peak at 1694 cm^{-1} is assigned to carboxylic acid. The spectrum matches a natural resin like Kauri copal, for example. Asian lacquer traditionally used in Cambodia for coloring Cambodian sculptures has a high peak at 1622 cm^{-1} due to the aromatic ring system (Christoph Herm, pers. comm., 29 July 2009) and does not correspond as well to the spectrum of the sample. However, Asian lacquer cannot be definitely identified with FT-IR in principle because of its broad bands.

The sample from Bakong not only shows a striking spectrum, but its cross-section also reveals a specific light yellow-orange fluorescence [Fig. 22.2]. Comparisons to the fluorescence of samples of Urushi, Kauri copal, Manila copal and colophony showed no match. More conclusive results concerning the characterization of the binder can be obtained by pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) (Simon *et al.* 2001), which has not yet been possible.

Figurative and Ornamental Paintings

The valuable remains of the decorative paintings in the temples Preah Ko, Prasat Neang Khmau and Prasat Thom were investigated in detail. In Prasat Neang Khmau, unfortunately, only very few remains are still visible. To provide a short overview, the descriptions by former researchers are compiled below. The technical examinations including painting materials, technique of execution and stratigraphy of

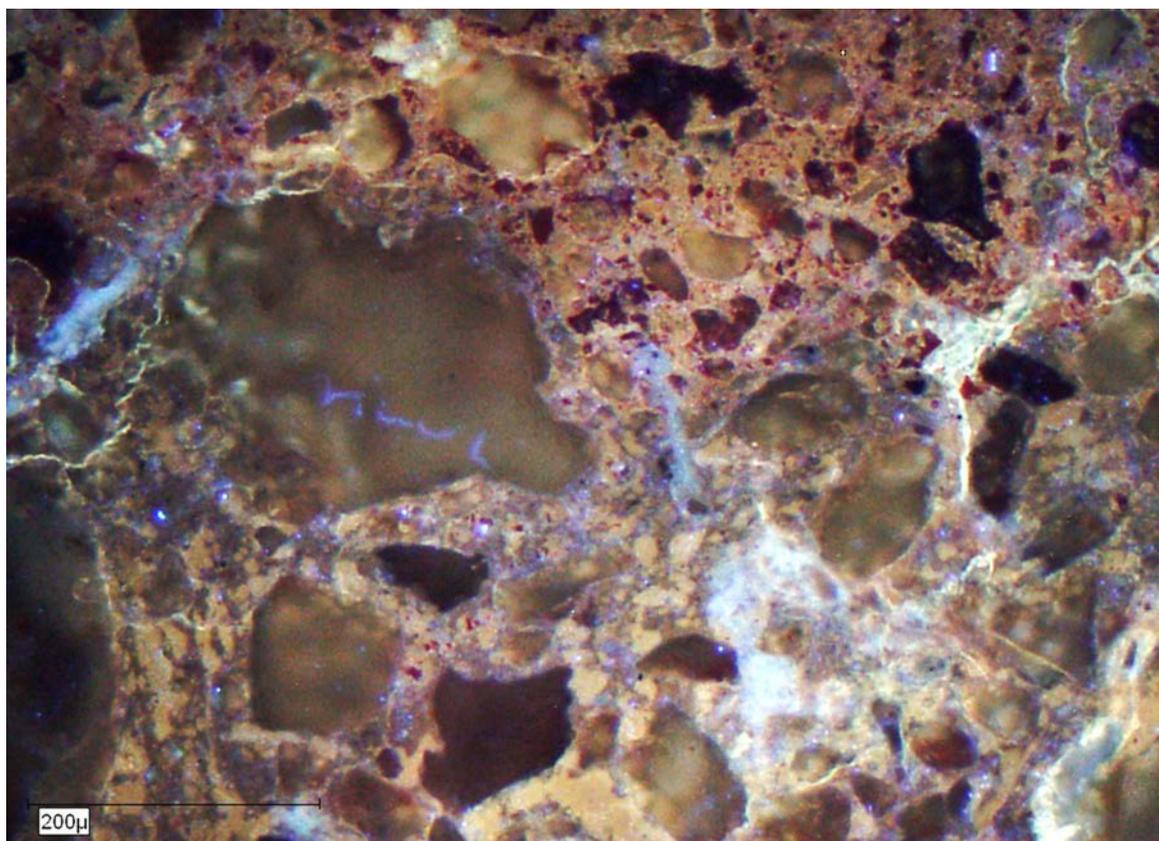


Fig. 22.2: Fluorescence photograph (Zeiss Filter set 02) of a cross-section of a sample from Bakong. Below: brown badigeon, above: red paint layer (Photo: S. Runkel).

the wall decoration of Preah Ko and Prasat Thom in Koh Ker are described in detail in the following section of the paper. The preservation state was recorded and mapped, and damage phenomena were described. Specific conservation proposals for further interventions on the objects are being developed based on this.

Prasat Neang Khmau, Ta Keo

Prasat Neang Khmau is located 52km south of the capital Phnom Penh in the Takeo province. It was, like its twin temple Prasat Kravan in Angkor, constructed under the reigns of Harshavarman I (c. 910–922 AD) and Isanavarman II (c. 922–928 AD) in Angkor, and of Jayavarman IV (c. 921–941 AD) in Koh Ker and subsequently also in Angkor. Two of the original five brick towers of Prasat Neang Khmau contain large-scale, but unfortunately poorly legible, figurative paintings.

The paintings of the northern tower are almost completely lost. The main focus of investigation is the paintings of the southern tower, the former central tower. Its interior has a nearly square ground plan with a side length of 3.6m and a wall height of 4.5m. For the exterior decoration only two carved lintels are preserved. Prasat Neang Khmau was first mentioned in 1913 in the inventory of Khmer temples of Parmentier (1913: 6–8). He provides a detailed description and even a drawing of the painting of the south wall (erroneously identified as the north wall), and half of the west wall. Parmentier understood the composition on every wall, including a central figure framed by a niche or other motives. The figure depicted on the south wall is a dancing deity with two adjacent figures. The one on the opposite wall is identified as a dancing Vishnu. His descriptions provide valuable information about the attributes that are no longer legible. Later, Henri Mauger (1936, cited in Marchal 1955: 153) created a graphic depiction of the preserved painting of the walls of both towers. The documentation of Mauger illustrates that there has

been an extensive loss of paint in the last 60 years. The main damage is an extensive crack system and open joints. But there are also many visible scratches in the paint layers, probably caused by vandalism of the prisoners detained in the brick shrines during the Khmer Rouge period.

Preah Ko, Angkor

The temple Preah Ko belongs to the Rolous group, the modern name of the former Khmer capital Hariharalaya, 15km southeast of Siem Reap in the Siem Reap district. It was built by Indravarman I and consecrated on 29 January 880 [A. Barth in Bergaigne 1893: (308–9) 128–9, fn. 3]. The slightly variant date of 25 January 880 has since been proposed (Golzio 2006: 41–4). The six brick towers of Preah Ko show the largest remains of exterior stucco decoration in Cambodia. Because of this unique decoration, it is considered one of the most important temples in Khmer architecture. Thus, various conservation projects have focused on the preservation of these sanctuaries, starting with the removal of vegetation in 1932. Its variety of outer ornamental decoration provides valuable comparative examples that help to supplement the findings of painted interior ornaments.

The main focus of the investigation at Preah Ko was the painted decoration inside the central-west tower. This tower hosts the largest amount of preserved paint with a three layer stratigraphy. Two different overlaying decorations that function as an ornamental border on the overall wall paint are still visible in the upper wall areas. The other five towers of the temple with significantly less preserved paintings have been used as supporting evidence.

The first paint layer consists of an overall wall paint applied on the brick surface. It is an orange-red layer of approximately 0.3mm with a high content of very fine quartz sand. This first decoration phase is only preserved in the higher wall areas until 150cm below the cornice.

In the uppermost area, traces of the first ornamental layer have been detected. Remains of a border become visible where parts of the covering of the second ornamental decoration have fallen off. Black ornaments are to be seen on a whitish layer. By gathering evidence from all six sanctuaries of Preah Ko, it is possible to describe this first decoration as a black floral and diamond-shaped ornament. It is best preserved on the west wall of the northwest tower. This pattern was recorded by Michael Falser (2002: 110; 2006: 150–1) during the analysis of the exterior decoration. Like the orange-red overall wall paint, the light ornamental layer shows a thickness of 0.3mm and a grain size distribution of up to 0.25mm. Due to coarse filler grains, the surface has a rough appearance. The black ornamentation lines were applied with a low viscous paint and therefore still reveal the roughness of the underlying layer. There are no deposits of dirt between both layers. This, and the similarities in the execution techniques, suggest that there was one decorative arrangement performed in a uniform work process.

In contrast, a thin dark brown layer can be observed between the two ornamental layers [Fig. 22.3]. The EDX analysis of this layer reveals an element composition of mainly phosphorus, along with aluminum, potassium and little iron and magnesium. This layer is interpreted as a deposit of weathering products, salts and dirt. The first ornamental decoration must have been exposed for some time before the repainting was carried out.

The third layer is the second and last ornamental decoration. This border covers the 38cm below the cornice. The pattern portrays tendril ornaments in black and red on a light background, framed downwards by three double red and black lines. It depicts a garland with alternating open lotus flowers and roots draped on a circumferential border. The cornice is also painted with an ornament of adjoining lotus leaves. Both ornaments correspond to the outer stucco and stone reliefs of the temple.

The last decoration is much smoother than the other two layers and is thus optically very well distinguishable [Fig. 22.4]. The bright white base coat consists of a white matrix with finely dispersed yellow pigments. On this light background, the black outlines of the tendril ornament were applied and then accentuated in red. The red paint sometimes covers the black paint strokes. Brushwork is visible in some areas and this decorative ornament is not carried out very accurately. This could be due to the distance between the decoration and the contemplator or a lack of artistic skills during the period of execution. Since attention to detail is a characteristic attribute of Khmer art, the last decoration phase might be dated as post-Angkorian, which is the only indication for an age determination.

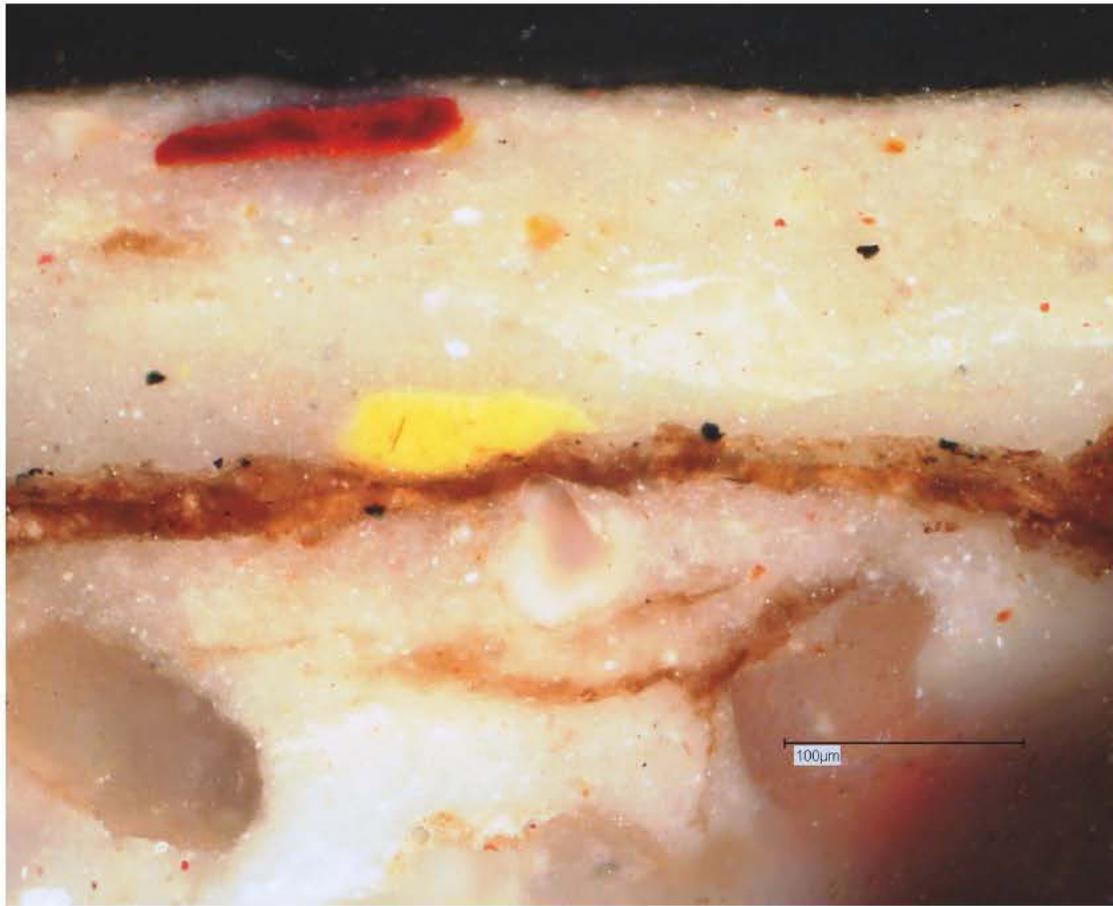


Fig. 22.3: Microscopic picture of a cross-section of a sample from Preah Ko. First and second decoration layers are divided by a brownish layer (Photo: S. Runkel).



Fig. 22.4: Wall surface showing the stratigraphy of three paint layers in Preah Ko — central-west tower (south wall). Orange paint layer, light paint layer with coarse surface and on top the last light paint layer with black ornaments and red accentuation (Photo: S. Runkel).



The state of preservation of all paint layers is stable. The adhesion to the brick surface and between the paint layers is remarkably high. The cohesion is also excellent. The fact that paint layers are only preserved in the higher areas of the walls might be due to the use of the towers throughout the course of Cambodia's turbulent history. The preserved areas of painted decoration are often restricted to individual bricks. This might be due to the different quality, porosity and capillary characteristics of the bricks.

Whitish veils and runs are noticeable on the paint layers. These salt deposits are extremely solid. Reducing the salt layers should only be stated after a damaging effect is proved and an analysis of the salt composition is made. Above all, a consistent and integral conservation plan for the interior decoration has to be developed first. The preservation of the remains has become an important issue after the first discovery of painted wall decorations in 1996. Initial preservation efforts were performed right away. Interventions to stabilize the towers and to control water infiltration were also executed (Lujan Lunsford 1996b: 73–80). The temple platform has been supplied with a drainage system and air circulation inside the tower is guaranteed by a protected opening at the top of the shrine.

Prasat Thom, Koh Ker

The city of Koh Ker is located about 120km northeast of Angkor in the province of Preah Vihear. Prasat Thom was used as the state temple of King Jayavarman IV between AD 921 and 944. Its brick towers are situated in the centre of the aligned temple complex framed by a moat. Remains of painted decoration were discovered by GACP members in 2003. The wall paintings are located in the longitudinal porch of the central tower and in some of the minor towers. The central porch tower hosts ornamental and figurative paintings. Unfortunately, its roof has collapsed and the preserved north and south wall are unprotected. Due to rising damp, humidity and water infiltration the microbiological impact is very high.

The base coat of the entire brick wall is executed in a thin layer of a brownish-red badigeon. Fragments of a horizontal border with ornaments in black on a white background are preserved. They reach from the cornice to 27cm below on the south wall [Fig. 22.5]. With regard to the decoration of Preah Ko and Prasat Neang Khmau, these fragments are explained as circumferential ornamental borders. However, few traces of this ornament in comparable areas support this hypothesis.

At the centre of the south wall, traces of figurative paint, like eyes, ears, a headdress and a hand can be found [Fig. 22.6]. These outlines are depicted in brown on a bright background. It is possible that the figures have been painted with a bright whitish color and were accentuated with the dark outlines afterwards. There are other outlines in black or red that probably depict garments.

The state of preservation is exceptionally poor. Micro-biological colonization is ubiquitous and flaking and powdering are the main causes of loss. The National Authority APSARA therefore erected a wooden shelter upon the request of the GACP in order to protect the paintings from the weather.

The minor towers show an ornamental decoration underneath the cornice. The walls are colored in a saturated red, applied directly onto the brick wall. The area 22cm beneath the cornice is painted in white and decorated with a black tendril ornament that is similar to the one in Preah Ko. The white area beneath the cornice has a lower border consisting of two horizontal black lines that separates it from the red section. The red wall itself is additionally accentuated with lancet arches in fine black outlines, representing lotus leaves. Between the peaks of the arches are gracefully painted flowers in white, that are absolutely unique in their execution [Fig. 22.7]. Another tower shows traces of the surrounding ornament and the lancet arches, too. All minor tower shrines were decorated in the same style.

Reconstruction of the Ornaments

The results of the detailed assessment of the remains are compiled to show a reconstruction of the painted inner decoration of the brick towers in Preah Ko and Prasat Thom. The reconstruction of the wall decoration is based on detailed photographs and scale drawings. Digital high-resolution photographs of the remaining paintings were then added on an in-scale elevation of the wall. The vector-based graphic and drawing program "Adobe Illustrator" proved to be suitable for graphical implementation.

Since the few remaining fragments of ornaments were recorded at various areas on the walls, they had to be composed like a puzzle. Their respective positions in height were retained as they were moved



Fig. 22.5: Brick wall in Koh Ker — Prasat Thom (central porch, south wall) with ornament: red ground coat with light yellow paint layer and black outlines (Photo: S. Runkel).



Fig. 22.6: Depiction of a head in Koh Ker — Prasat Thom (south wall) (Photo: S. Runkel).





Fig. 22.7: White flowers on red decorated walls in Koh Ker — Prasat Thom (Photo: S. Runkel).

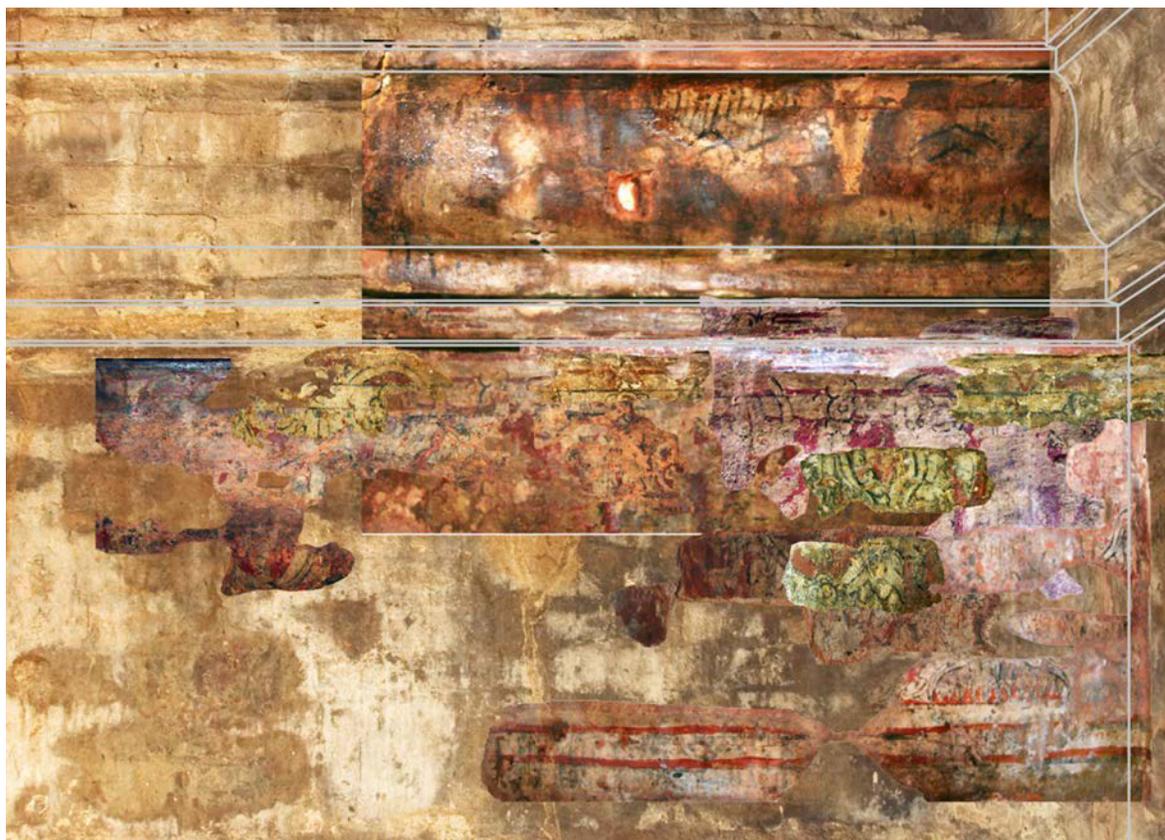


Fig. 22.8: Mosaic of the remains of decorative paint in the central west tower of Preah Ko (Photo: S. Runkel).





Fig. 22.9: Ornament “3-part curve and lotus” framed by lotus leaves in Preah Ko — south (pediment) of the central-east tower (Photo: S. Runkel).

closer together horizontally [Fig. 22.8]. The sequence in the pattern repeat was not always implemented regularly. As the distances vary, some of the ornament fragments could only be assigned after a rough sketch of the ornament rapport to add further details. The pattern of the outer decoration was consulted at this point [Fig. 22.9].

The patterns of the second decorative painting of Preah Ko [Fig. 22.10] and the painting of a minor tower of Prasat Thom were digitally reconstructed. Both decorations are tendril ornaments that are suspended from a horizontal band alternating with open lotus flower and leaves around a rootstock. Additionally, Preah Ko shows evidence of a painted cornice with lotus leaves.

Comparison of the Decoration Systems

The design of the decorations varies even between locally and chronologically close temples like Bakong (AD 881) and Phnom Bakheng (around AD 900). Temporal and local relations can only be drawn sporadically. The younger temples built by Rajendravarmān show a similar decoration system. The towers of East Mebon (AD 953) and Pre Rup (AD 961) are decorated with brick-colored wall paint and an accentuated dado. Baksei Chamkrong (AD 968) at least shows the brick-colored wall paint [Table 22.1].

A further comparative aspect can be the arrangement of the tower shrines in the temple complex. Here again, the decoration of East Mebon and Pre Rup can be related to each other since they are both main towers in the quincunx-arrangement. The towers of Bakong and Phnom Bakheng are situated around the pyramids functioning as minor towers. Both are painted with monochrome red wall paint.

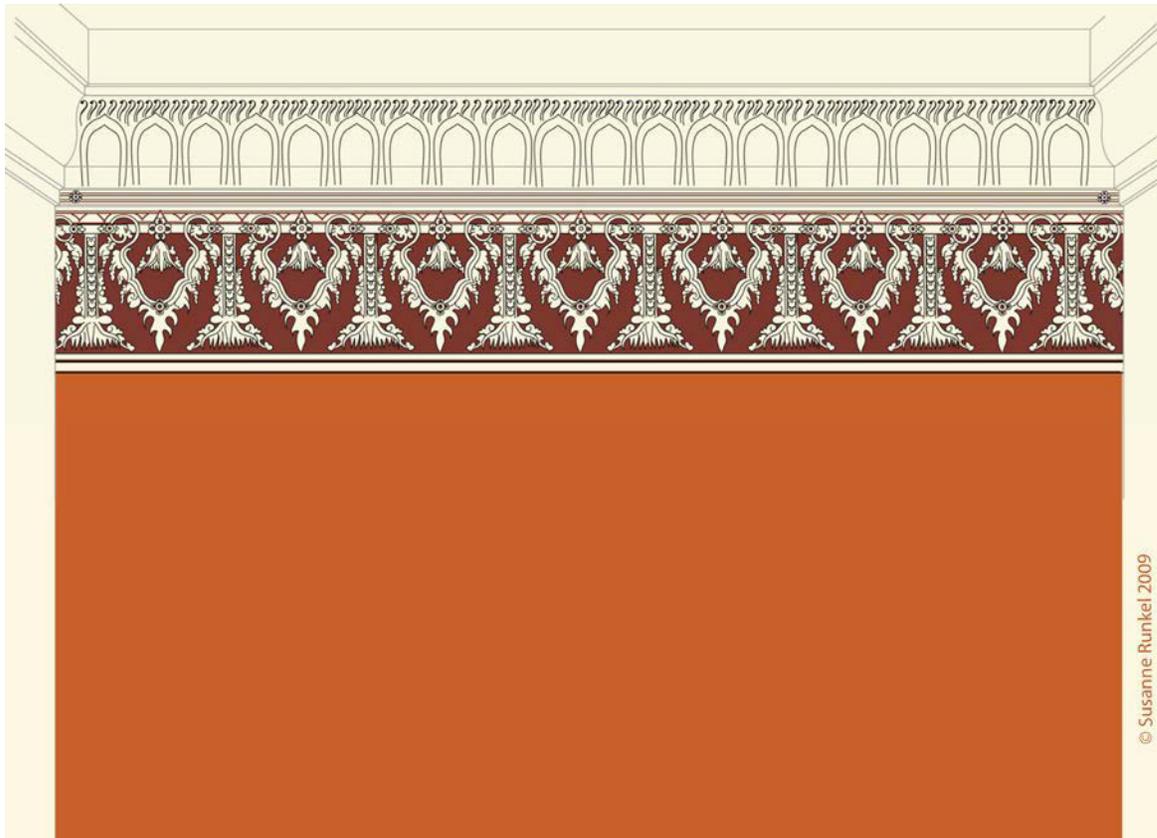


Fig. 22.10: Reconstruction of the second interior wall decoration (Preah Ko — central-west tower) (Reconstruction: S. Runkel).

The religious and political significance of the structures can be another criterion of the interior design. Since this information is not available for each temple, we can only speculate on the interpretation of the ornamental and figurative wall paintings. Prasat Thom was the state temple of Jayavarman IV. Thus it required an impressive entrance decorated with elaborate figurative paintings. The temple Preah Ko is known as the first Indravarman I building. Its exterior decoration of stone and stucco reliefs is outstanding. So was the interior decoration. The historic background of Prasat Neang Khmau built during the kingdom of Isnavarman II has not yet been established. It shows great resemblance to its “twin temple” Prasat Kravan in Angkor.

Conclusion

Until now only very little attention has been paid to the importance of the inner painted decorations in the brick temple towers of Cambodia. Apart from the description of the wall paintings in Prasat Neang Khmau by former French researchers, no other relics of coloring inside the brick towers have been mentioned in the archeological literature of the region. After the discovery of painted interior decoration at Preah Ko in 1996 and at Koh Ker in 2003, the need for a detailed investigation into these remains and the technique of execution became obvious.

An inventory of 105 towers in 19 temples was compiled by the scientific study group within GACP. This revealed a stock of 43 towers which still have remaining interior decorations. It was possible to document paint relics in 16 of 19 temple complexes for the first time. The surveyed and documented wall painting fragments are the only evidence of the interior polychromic design of Khmer brick temples. From the results of this study, it can be inferred that the interior of all towers was originally decorated with wall colorings and occasionally with ornamental and figurative wall paintings. Despite the few remains it is possible to see that the quality of the paintings varies significantly.

The rather simple decorations of brick-colored wall paint were applied directly onto the brick walls, while the red wall paints were sometimes put on an equalizing base coat. This first layer functioned as a badigeon or wash. In the lower parts of the walls the dado was often accentuated by red or black lines.

Ornamental decorations adorned the upper wall areas in circumferential borders underneath the cornice. Ornamental and figurative paintings were executed in black, red and white on a light-colored or red background without a base coat. Pigments used were clay pigments and cinnabar. The binding medium cannot be clarified yet because of the minimal residues in the samples. Results of analyses showed similarities with natural resins. There are plans for further investigation. To enable a reconstruction of the inner decoration, the information gained from the few fragments of paint were transferred to other wall areas or even neighboring towers, due to the strict principle of symmetry and repetition in Khmer art. The patterns of the painted ornaments were compared to the outer stucco and stone ornamentation. A direct comparison was only possible at Preah Ko where a clear relation between the external and internal decoration could be established.

The state of preservation of the wall paintings is dependent on the condition of the building structure and the maintenance of the towers. Causes of loss are humidity and salt contamination as well as micro- and macro-biological colonization. The high salt content within the walls is caused by bat excrement.

In order to preserve the remaining wall paintings in the long term, preventive measures have to follow a consistent and integrated concept for the towers and their decoration. Ongoing and future projects in Khmer temples have to take into account that there might be valuable remains of interior decoration. These remains need to be studied, documented and saved by individual conservation interventions.

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