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Conservation of Built Heritage in China

- with a Focus on Material Conservation

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Abstract: This paper focuses on developments in the area of material conservation and implementation of conservation – restoration works at built heritage sites in China, and in particular on the contribution of the Tongji Architectural Conservation Laboratory (Tongji ACL) at Tongji University Shanghai. During the past seven years the Tongji ACL has been working on numerous projects to develop conservation solutions for architecture and other immovable cultural heritage sites based on scientific research and promoting international best practices.

Since the formation of China ICOMOS in 1993 and the adaptation of international conservation principles in 2000, the field of heritage conservation is developing and a growing number of professionals are striving to manage the vast amount of cultural heritage in China. While much effort is put into the conservation of national preservation sites many sites face problems with inadequate conservation procedures, especially in rural areas lacking budget, skilled professionals and quality control for interventions. On project level, many sites face problems due to the lack of knowledge on historical and modern building materials and the availability of specialists in material conservation. Using two case studies as examples, this paper shows challenges and achievements the Tongji ACL has experienced during projects. Responding to the need for guidance in the identification and implementation of conservation and restoration works, the Tongji ACL has been developing and publishing technical guidelines combining international standards and principles and well-established systems of approved technologies in conservation adapted to Chinese sites and building materials. The development of these guidelines is a result of the close collaboration and exchange of experiences with international specialists through pilot projects and the organization of conferences focusing on specific technical issues.

Keywords: Architectural conservation in China, Tongji Architectural Conservation laboratory, development of technical guidelines, conservation implementation

1 Introduction

China's heritage architecture is extremely multifaceted. Styles and techniques of traditional architecture vary from region to region, due to locally available resources related to climate and geology, and a variety of styles from different ethnic groups. Due to the vast size of the country and the significant variations in topography, China's climate is very diverse and ranges from tropical in the south to subarctic and alpine in the north. As a result, similar building structures are exposed to very diverse climatic conditions and the degradation of historic structures varies significantly. In addition to Chinese traditional architecture, there is also a variety of western influenced architecture, e.g. colonial style buildings, often with a mix of Chinese and Western architecture styles, decorative elements and painting techniques.

Following the formation of China ICOMOS in 1993 and the establishment of links to international professional organizations such as the Getty Conservation Institute (GCI), the *Principles for the Conservation of Heritage Sites in China (China Principles)* were promulgated in Chinese in late 2000 with the approval of the SACH (State Administration for Cultural Heritage). The China Principles provide an integrated and methodological approach to the conservation and management of sites, in compliance with the existing legislation of the People's Republic of China [Agnew and Demas 2004]. ICOMOS China initiated the revision and expansion of the China Principles in 2009, which is now nearly complete [Zhou, 2014].

But despite the development of conservation principles and the growing number of declared and listed national and world heritage sites, China's built heritage continues to be threatened by rapid development and the profit local governments can gain from land sales that involve the demolition of existing structures. Another serious problem is the lack of education in heritage management of bureaucrats working in local cultural departments. While conservation principles are revised and improved and more and more people in China are educated in the growing numbers of available educational programs on heritage management, often there is a lack of basic understanding of materials and the development of conservation techniques. As a result, incorrect materials and measurements are applied in numerous conservation projects, which do not consider the basic physical and chemical properties of the historic fabric. Many of these conservation interventions have caused more damage to the historic fabric than natural decay before the treatment (Bild 1: p 3).



Bild 1: Cement plaster used for repairs of a brick wall at St. Francis Cathedral, built 1716 in Xian. The repair work at the wall base as well as repairs to the damaged bricks were carried out with incorrect materials (cement) causing damage to the original façade.

2 Administration Systems, Charters and Principles

Today, China is the largest country in Asia with a territory of 9,596,961 km² (almost 27 times the size of Germany), with a long history of continuous cultural development, and many ethnic groups resulting in a vast amount of built heritage. China has two institutions responsible for the control of conservation of built heritage: the State Administration for Cultural Heritage (SACH), and the Cultural or Heritage Bureau in the Ministry of Housing and Urban-Rural Development (MOHURD). However, for the most part, the preservation of immovable cultural heritage sites is managed only by local governments. Since 2000, China introduced the Principles for the Conservation of Heritage Sites in China (drawn up in collaboration between China ICOMOS, The Getty Conservation Institute and the Australian Heritage Com-

mission) [Agnew and Demas 2004], combining existing regulations on the protection of cultural relicts with international conservation guidelines. In daily practice however, in many cases these guidelines are not fully adopted or implemented.

In a press conference at the Ministry of Culture held on May 25, 2006 in association with the opening event of the first national Cultural Heritage Day in China, Shan Jixiang, the General Director of the SACH, announced to the media that the nation has about 400,000 immovable heritage sites [Shen and Chen, 2010]. In December 29, 2011 the number of immovable cultural heritage sites released by SACH after the 3rd national survey of cultural relicts reached 766,722. Meanwhile the same survey found that over 44,000 formerly registered relicts have disappeared, partly due to demolition for new construction [Beijing News, 2011].

Besides the above mentioned heritage sites, China has, to date, 48 properties inscribed in the UNESCO World heritage list, 38 being cultural and mixed cultural and natural sites. China approved the UNESCO World Heritage Convention in 1985 and the number of UNESCO sites since then is ever growing. However, as the sites nominated for the Word Heritage list are selected by the states, in China this process has particular political resonance. Looking at the distribution of UNESCO sites across the country, it can be observed that there are no UNESCO World Heritage sites in the provinces of Qinghai and Xinjiang [Silverman and Blumenfield 2013].

In addition, UNESCO sites also contend with tourism problems and pressures. While on one hand gaining UNESCO World Heritage status can help regional economic development, the growing numbers of national and international tourists in China present a serious threat to the preservation of the sites. Additionally, tourism is often the reason for the destruction of built heritage where heritage sites are presented as historical theme parks by rebuilding of historical structures to house and entertain a larger number of tourists.

China has much more built heritage in need of conservation than those sites that are nominated or listed as UNESCO World Heritage sites. Especially when tourism, with its positive and negative sides, has not arrived, many sites in China deal with budgeting constraints: In poor rural areas of West and Middle China, the lack of financial support from either the central or provincial governments for conservation projects prevents compliance with the working procedures prescribed in the Principles for the Conservation of Heritage Sites [Zhu, 2012]. In addition, local cultural offices are quite often staffed with bureaucrats whose sense of the importance of cultural heritage management is weak. Moreover, their misconduct in these matters is sometimes self-interested [Shen and Chen, 2010]. And even if the will and the budget are there, many cultural departments deal with the problem of non-specialized staff. Especially in smaller communities, members of the local cul-

tural offices often have no education or experience to deal with building conservation issues. The China Principles, while revised and extended to important fields such as urban landscape and intangible heritage, are, in respect of technical aspects, often not sufficient, especially without specialized training and understanding for material degradation processes. In addition, there is often not sufficient quality control for the implementation of conservation works. This leads to cases of inappropriate reconstruction processes, and replacement of original components with inadequate materials and dismemberment, resulting in the loss of integrity and authenticity of many heritage sites.

3 Education and Training

In consequence of the above-mentioned adoption of international conservation principles, more and more universities in China offer educational programmes in cultural heritage related fields, but education in the field of material conservation is very limited. The few courses and workshops that cover the issues of material conservation are offered by Beijing University and Xi'an Northwest University, however they are more focused on the conservation of museum objects and artefacts than on architectural conservation of the built environment. Similar to many other Asian countries, in China conservation education and related courses in architectural departments, mainly focus on site management, tourism and policies. As a result, there is a lack of professional conservationists in China who are trained to assess materials and their condition and to analyze symptoms and causes of deterioration. These professionals should be able to research and document an object on site and assess materials and their conditions as well as identify symptoms of deterioration and design and implement treatments for long-term conservation and preservation [Cody, Fong 2012]. These terms are also used to define the competences of conservation-restoration professionals [E.C.C.O., 2011], a profession that does not exist in China and to an alarmingly large amount of people not even known about.

The University of Hong Kong (HKU) is currently expanding its Architectural Conservation Programmes to introduce more material conservation related courses in the curriculum. These courses mainly concentrate on introducing case studies and discussing problems in material conservation with students. Students learn to understand why and how materials deteriorate and what kinds of interventions comply with best practices. With the introduction of a laboratory, students will be instructed in the basics of chemistry and instrumental analyses to understand what results can be achieved with which methods, and how to apply them in the conservation process.

3.1 The Tongji University Historic Conservation Program

Approved by the Ministry of Education in 2003, Tongji University started the Historic Conservation Program, which was the first of its kind in Mainland China. The students are expected to have basic knowledge and skills in architecture design, history, and technology, and are equipped with necessary skills for the conservation and revitalization of historic built environments. They are to be architects, specialists and leaders with higher architectural attainments and special skills for conservation. Within the past decade, the program has recruited a large group of teachers including scholars and practicing professionals, invited distinguished professors from internationally recognized universities to teach core courses and give public lectures, built the Architectural Conservation Laboratory for first-class teaching and research activities, and opened eight new core courses including 'Form & Craftsmanship of Historical Architecture', 'Chinese Cultural Heritage Studies', and 'Conservation Technology'. All these courses integrate lectures, experiments, and site studies, greatly enhancing students' understanding of Historic Conservation as an independent discipline.

3.2 The Tongji University Architectural Conservation Laboratory ACL

The Tongji ACL was founded in 2008. It is a research and teaching laboratory under the College of Architecture and Urban Planning. It comprises specialized laboratories in the conservation of wood, stone, lime plaster and bricks and earthen architecture. It is working under 2 key pillar national research projects and two national science funds. It also collaborates with municipal government agencies to carry out research on local architectural materials, climate monitoring and controlling, and sustainable conservation techniques. An example is the research project on the conservation of the Igreja de Nossa Senhora da Guia in Macao. The project used environmental monitoring, hygrothermal simulations as well as analysis of the impact of variation between the air-conditioned indoor and subtropical outdoor climate on the condition of the building fabric and material analysis. In addition, a conservation concept for the wall paintings was developed (Bild 2: p. 7).



Bild 2: Conservation of the Guia Chapel in Macao, an example of international cooperation between Tongji-ACL and national and international institutes.

Following international best practices in conservation the Tongji ACL is developing and implementing conservation solutions for built heritage and shows a growing list of references all over China, in Hong Kong and Macau.

These projects serve at the same time as examples in conservation education. Students are introduced to the scientific approach in conservation and learn how wrong materials used in conservation will produce more damage and diminish the authenticity of heritage architecture. Through consulting as well as publishing of guidelines for the implementation of conservation works (see Chapter 4) the Tongji ACL also provides support to professionals working in the heritage conservation field to improve solutions for material conservation related issues at their conservation projects.

Additionally, the Tongji ACL organized international conferences and workshops focusing on technical conservation issues such as the *International Conference on Sustainable Building Restoration and Revitalisation 2013* organized by Tongji University, HAWK Hildesheim, UNESCO WHITRAP (Shanghai) and WTA-International and the *International Workshop on Conservation Technology for Roof Systems of Chinese Traditional Architecture in Taiyuan, Shanxi 2014* organised by Tongji University, HAWK Hildesheim and Hefei University.

4 Implementation Principles and Development of Technical Standards and Guidelines

The management of many heritage conservation projects in China, even those using international best practices, often lack knowledge on materials when it comes to details in implementation. The Tongji ACL has made one of its main concerns the education of professionals who work in the field of heritage conservation by sharing knowledge on material degradation and material compatibility, through publishing project documentation and guidelines on technical issues in the conservation of building fabric.

The authors fully agree with the concept of values based conservation, which has played an important role in the recent development of conservation internationally, especially for urban and area conservation and challenges in Asia (as discussed in detail for example in the Hoi An Protocol [Engelhardt and Rogers, 2009]) and the revision of the China Principles. However, looking at materials conservation in specific, it may also bear risks. The concept of values based conservation developed from the background of western conservation practices with a strong focus on conservation of historic building fabric. It should be considered that, without this background and without the existence (or establishment) of conservation-restoration work as a recognized discipline, values of material authenticity may not be recognized appropriately and valuable historic evidence may get lost. It is therefore important to combine the study of traditional building techniques and materials with a strong scientific approach and focus on the understanding for the physical conditions and causes of damage of historic structures in order to determine the requirements for the conservation interventions. One pilot project in this area is the research project on the investigation of the performance and durability of traditional roof constructions and historic cladding materials in Shanxi Province initiated by Tongji ACL, HAWK Hildesheim and Hefei University in 2014 (see Chapter 5.1). It is anticipated to expand the study of historic building materials and traditional techniques of different regions in China in similar projects.

Building conservation in China today continues to have many examples of “beautification” repairs. Historic structures are repaired with cement and repainted with assumed weathering resistant modern paint material without understanding of chemical and physical compatibility. This may not alter the traditional shape or the style of living in the buildings, but it may alter their authentic appearance and, maybe even more critical, it doesn’t consider long-term damage to the structure that can lead to its complete degradation and loss in future. As a result, many historical structures experience further damage, lack of authenticity and loss of im-

portant historical evidence due to the application of incorrect materials. The investigation of the decorative history of buildings through the study of historic records in combination with on-site investigations of paint finishes for example, remains an uncommon procedure and practice in the conservation of built heritage in China. The second case study (see Chapter 5.2) demonstrates the involvement of the Tongji ACL in the conservation of the historic centre of Haikou where a balance between preservation and restoration was applied depending on the condition of the fabric.

After working for several years combining scientific research and best practices in conservation interventions, the Tongji ACL observed difficulties in the implementation and past mistakes made in several conservation projects across the country. It seems obvious that what is missing are detailed specifications and technical guidelines for damage assessment and conservation interventions. In 2014 the two Volumes "Proposed Technical Guidelines for Conservation of Historic Architectural Materials " and "Architectural Conservation and Technology" [Dai and Zhang, 2014; Dai, Lu and Zhang 2015] were published by the Tongji ACL. These technical guidelines contain a combination of international standards and principles and well-established systems of approved technologies in conservation that have been adapted to Chinese sites and building materials. The guidelines provide diagnosis and evaluation methods and detailed instructions for solving common building defects such as, for example, rising damp and salt damage or common interventions such as façade cleaning methods. The guidelines are designed to promote the procedure adopted by the Tongji ACL and share experiences from Chinese sites to improve procedures and results in conservation interventions. The published guidelines aim to assist Chinese professionals in the field of heritage building conservation to make informed decisions towards sustainable conservation concepts on a technical level. These concepts include prior identification of the damage and source in order to avoid incompatible and damaging treatments and the detailed identification of the requirements for effective and appropriate conservation treatments.

5 Case Studies

As previously mentioned, the Tongji ACL has been and is currently involved in numerous projects in various fields of the conservation of China's built heritage dealing with the conservation and treatment of many diverse materials. The following examples show two innovative projects completed by the Tongji ACP and describes achievements as well as challenges and problems faced during the process.

5.1 Conservation of Roof Systems in Shanxi Province

Site description

Temple complexes in the Shanxi Province are known as some of the most beautiful and elaborately decorated temples in China dating from ca. 11th to 12th century AD. It is known that approximately 50% of the existing remaining historic buildings in China from this time period are located in the southern Shanxi Province. A large number of these historic buildings were built with richly decorated traditional wood construction. The building decoration includes engraved bricks, stone carving, woodcarving, painted woodwork, wall paintings and painted sculptures giving these buildings and their decoration high artistic and historical value. The temple roofs are typically tiled with different types of traditional Chinese ceramic tiles, usually in the monk and nun or imbrex and tegula style, glazed or unglazed and bound with lime or clay mortar. Often the ridges, especially towards the gable, are decorated with specially arranged tiles or ceramic figures and every row of tiles towards the eaves is finished with a special decorated tile (Bild 3: p. 11).

During an ongoing pilot project, a collaborative research project between the HAWK Hildesheim and the Tongji ACL, the performance and durability of roof construction and historic cladding on temple buildings in the southern Shanxi Province was investigated in order to find sustainable concepts for their conservation. The survey included several temple sites in different states of condition, from recently renovated to abandoned and heavily damaged.



Bild 3: Example of traditional roof of a Tang Dynasty temple with ridgeline figures located in Shanxi Province.

Key aspects of the project

In several field trips and workshops, data on roof construction techniques, wood species and wood condition of the temple sites was recorded and analyzed. Roof construction and cladding damage were compared and roof components were investigated in detail. As humidity is usually the primary factor of deterioration processes, investigation and simulation calculations of the humidity behavior in the building materials related to the climate were made to determine the influence of temperature, humidity and rainfall on the construction elements. These investigations help to determine how much humidity is absorbed by the different materials after rain and how long the humidity remains in the system.

The aim is to gain a detailed understanding of the physical conditions and define weakness and sources of damage. Comparing a large number of sites has demonstrated differences in the quality of the techniques used for roofing. Pure lime plaster, for example, has shown to be a more durable and show better performance used as binding mortar between the tiles than lime-clay plaster (Bild 4: p. 12). It is assumed that differences in the plaster are partly due to availability and prices of these resource materials. A specific type of Chinese roof tile, the Qing Gun tile,

which is described in the records of historical Chinese building techniques was identified here. It is a special fired tile with a smoothed but unglazed surface. Scientific investigation shows that the tile has an extremely low water permeability compared to the common unglazed tiles.

While it is usually desirable to design conservation concepts with materials as similar as possible to the materials found on site or by applying local techniques, this example shows that the traditional technique must first be defined and understood in context. The approach of explaining the performance of traditional techniques scientifically helps to define possible deficits in the historic structure and possibilities to improve the performance of the building part during conservation. This approach takes place not with the use of foreign materials or high-tech solutions, but by understanding traditional materials and adapting their application techniques.



Bild 4: Roof construction details. Differences in plaster material used for tiling were investigated.

Results

The research project on roof constructions in Shanxi province is actually a reduced version of the initially intended *Research Project for the Development of Guidelines for Conservation of Traditional Architecture in Shanxi Province* initiated in 2012. The project was planned to include detailed investigation on traditional materials and techniques in combination with climate monitoring and understanding of the building physics in the centre of the project. Additionally workshops were to be included on conservation principles and site management in order to preserve the unique settings of the temple buildings and raise awareness of the values of the historic villages and vernacular houses in their surroundings. However, as a result of the slow response of the local government offices, the continuation of the project in the future is not guaranteed.

It is hoped that the successful outcome of the current project will inspire further projects and expand the workshops to additional building structures and eventually to more and more regions and building types within China.

5.2 Conservation of Shop Houses at Haikou Zhongshan Road, Hainan Island

Site description

The historic centre of Haikou City, the capital of Hainan Island Province in the South China Sea, features several areas with contiguous street façades of historic shop-houses built before the 1930's. These primarily two-three storey buildings integrating Chinese and European architectural styles can mainly be found in South China and Southeast Asia (for example at Malaysia's UNESCO World Heritage site *Melaka and George Town, Historic Cities of the Straits of Malacca*). The shop-houses are built as row houses and usually feature a commercial unit on the ground floor open towards public sidewalk arcades with residential units above (Bild 5: Bild 6: p.14).

Most of Haikou's shop-houses are constructed in reinforced concrete with mixed basalt-brick masonry and lime plaster facades. These shop-houses in the city centre of Haikou are not registered as national monuments, however some of them are part of the listed ten most famous historic streets in China.

Beginning in the 1990's, initial efforts were made to restore Haikou's historic shop-houses, but were largely unsuccessful. Many of the buildings were repaired or partly reconstructed with concrete and cement plaster and although there was historic evidence of different colour schemes on the buildings, most of the renovated buildings were painted grey or ochre. No research on historic materials or colours was carried out before the Tongji ACL was involved.



Bild 5: Shop-houses in Haikou, on North Boai Road, before conservation.



Bild 6: A shop-house in Haikou City, on North Boai Road, before conservation.

Key aspects of the project

In 2010, the Tongji ACL was invited to consult with the local government in the restoration of the shop houses along Zhongshan Road in Haikou. The proposed restoration work however was mainly limited to focus on the upgrading of the facades. The original coloured lime plaster façades and wooden window frames were restored using historic painting techniques and the colour scheme for repainting was chosen according to sample investigations of the original materials and colours in the laboratory (Bild 7: p.15). Some extant gratifies and propaganda signs from 1950-1960's were also preserved [Dai et al 2014]. The restoration of shop-houses along Zhongshan Road was successfully accomplished by end of 2012. The local government is making efforts to use the same restoration methods during the current restoration of North Boai Road in Haikou. A publication, "A Technical Guideline for Facade Restoration of Haikou Shophouses" is currently under progress and is expected to be published by October 2015. This publication will highlight the risks resulting from incorrect conservation practices and demonstrate solutions following conservation best practices including detailed specifications for implementation.



Bild 7: Colour investigation and exposure of decorative plaster at a shop-house in North Boai Road in Haikou before conservation

Results

Local construction companies applied the described conservation approaches to the shop-house facades as is successfully demonstrated at Zhongshan Road more than on other streets, partially related to budgeting issues and time management constraints. Investigation on the decorative history of the buildings was not carried out consistently and the use of appropriate repair materials was not always sufficiently controlled. During site visits by the Tongji ACL - in 2014 for example, new cement repair patches were observed on brick-lime plaster structures. While the original conservation approach for this project included a detailed study of the original wooden joineries and their decoration and was intended to maintain and repair several well-preserved wooden components, this was not fully realized in the implementation. The joinery was mostly entirely replaced and while the design was chosen to roughly match the historical examples in general, it does not follow any research done on the individual buildings (Bild 8: p. 16).



Bild 8: North Boai Road, Haikou after conservation

Parallel to this conservation work in the streets with existing historic shop-houses, other streets in the vicinity have been designed with fake historic facades in front of newer structures, which replaced the former shop-houses in the 1950s to 1990s

(Bild 9: p. 17). The presence of the fake shop-house facades clearly shows confusion in application and in the expected results of the conservation of the city centre by the local authorities. In combination with poor interpretation of the sites in the areas where the shop-house conservation work was done properly, the presence of “fake” shop-houses may lead to confusion of the public and visitors in their understanding of the place and in their understanding of proper conservation works.



Bild 9: Building of fake shop-house facades in the vicinity of Zhongshan Street, Haikou.

6 Outlook

With the recently growing awareness of the importance for the conservation of Chinese villages and vernacular architecture, there is also a growing demand for conservation solutions, which can be carried out as far as possible with locally available materials and affordable techniques. The continued research of historical techniques and their advantages and weaknesses is therefore an important area of study. Both in order to develop sustainable conservation techniques and to preserve the knowledge of historic techniques which otherwise will soon be lost.

Local conservation departments are in need of detailed guidelines to understand and control the requirements for the conservation of the materials in general but also specifically tailored to local traditions and climatic conditions. The development of detailed technical guidelines, such as those developed for roof systems in Shanxi Province, should be promoted by municipal governments and developed in collaboration with scientific research institutes.

The guidelines developed and published by the Tongji Architectural Conservation Laboratory were developed in collaboration with international specialists. The conferences and small workshops organized in collaboration with UNESCO WHI-TRAP, WTA, overseas universities and private companies to exchange experiences has been fruitful and has led to new achievements in conservation projects in China. Research on the application of approved western conservation technologies adapted to conditions in China will therefore continue to be a focus for the Tongji ACL. Through continued publication and education, the Tongji ACL hopes its future contribution will gradually close the gaps in the field of conservation of built heritage in China.

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