



# PAST AND PRESENT OF THE EARTHEN ARCHITECTURES IN CHINA AND ITALY



Edited by  
Loredana Luvidi, Fabio Fratini  
Silvia Rescic, Jinfeng Zhang



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### Front-page image captions

1. TECLA (Technology and Clay) 3D printed house by WASP and Mario Cucinella Architects, Massa Lombarda, Ravenna, ITALY (2021)
2. Ruins of a vernacular building in Sant’Omero, Abruzzo, ITALY (by Dalila Fortunato and Anna Jaroszewski, 2020)
3. Ruins of Gaochang ancient city, Xinjiang Province, CHINA (by Fabio Fratini and Loredana Luvidi, 2016)
4. Keziergaha beacon tower (Han Dynasty) in Kuche city, Xinjiang province, CHINA (by Center of Conservation of Xinjiang Cultural Heritage, 2020)

# TABLE OF CONTENTS

Foreword	
Gilberto Corbellini .....	5
Chai Xiaoming .....	6
Introduction	
Loredana Luvidi, Fabio Fratini, Silvia Rescic and Jinfeng Zhang .....	7
Part 1 - Historical use of earthen materials for architecture	
Earthen Architectures: history, typologies and construction techniques	
Manuela Mattone .....	11
Conservation of earthen architecture: an overview of international guidelines and resolutions	
Carla Bartolomucci .....	23
Part 2 - Earthen constructions in Italy and China	
Historical Earthen Architecture in Italy	
Maddalena Achenza .....	39
Earthen houses in Abruzzo Region (Italy)	
Silvano Agostini, Gianfranco Conti .....	57
The status of earthen sites in China	
Juwen Guo .....	69
Part 3 - Conservation of earthen architecture sites in Italy and China	
Earth Materials: characterization and traditional/innovative techniques of conservation	
Fabio Fratini, Loredana Luvidi, Silvia Rescic .....	85
Earthen construction and seismic action: new perspectives between tradition and innovation	
Luisa Rovero, Giulia Misseri, Ugo Tonietti .....	101
Conservation of earthen architecture sites in China	
Xiao Zhou, Shuai Tian .....	115

## Part 4 - New perspectives in earthen architecture in Italy and China

Overview of contemporary earthen architecture in Italy Eliana Baglioni .....	135
Earthen 3D printed constructions towards a new high-efficient way of building Massimo Moretti, Alberto Chiusoli, Lapo Nardoni, Francesco De Fabritiis, Massimo Visonà .....	147
Research and Practice of Contemporary Earthen Architecture Mu Jun, Zhoui Tiegang, Jiang Wei .....	157

## Part 5 - Case Studies

Experimental approaches for the conservation of the Ruguan Yao kiln site in Henan province Jinfeng Zhang .....	177
Conservation Measures of Ancient City Ruin of Gaochang Jicai Lu .....	191
Archaeological Site of Lajia Ruins: preliminary study on the screening of reinforcing materials for earthen ruins Min Fan, Yingyi Fu, Yue Chen, Guangzhao Zhang .....	201
Preservation of the CHANGSHA Tongguan Kiln Site: evaluation of earth properties and reinforcement effect of treatments Ya Xiao, Weiqiang Zhou, Feng Gao, Haibin Gu, Yun Fang, Shaojun Liu .....	215
Earthen walled villages in the Shanxi Province: Laoniawan (老牛湾) case Laura Genovese, Loredana Luvidi, Roberta Varriale, Fabio Fratini .....	229
Mud brick architecture in Sardinia. Sulcis as case study Marco Bianchi, Massimo Botto, Paolo Pasci .....	239

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# EARTHEN WALLED VILLAGES IN THE SHANXI PROVINCE: LAONIUWAN (老牛湾) CASE

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## GREAT WALL RURAL SETTLEMENT REGION

The Laoniuan valley (Fig. 1), in Pianguan County, Shanxi Province, for centuries represented the outer limit of imperial rule and there remain portions of the Great Wall, which rises and falls according to the ancient erosion gullies of the earth. Along the mountain ridge, great circular embankments still stand where once beacons were lit to warn of invasion from Mongol horsemen. Here the main long, narrow road circles sweeping mountains, flanks the terraced, green fields interspersed with vernacular rural villages, thus composing a very unique natural and human landscape.



Fig. 1 A view from the Laoniuan Valley to the Yellow River. On the left promontory, there is the ancient Laoniuan Fort and village, on the other, a modern village

The Laoniawan village (Lat. 39 ° 38 '11.71 "N Long. 111 ° 26 '11.66 "E, s.l. 1026 m) is a very ancient one. Since the beginning of XV cent., under the Ming dynasty (1368-1644), it raised as fortification occupying a dominant position on an important landing along the Yellow River, playing a strategic role for the defense of borders and for trade with the Tartars, on the Mongolian side of the river.

Under the Qing dynasty (1644-1912), when emperors no longer stationed troops in Laoniawan Castle, some of the soldiers remained here becoming farmers or retailers, continuing trades to Tartar, and building houses in or near the walls of the fortress. As an increasing number of people moved to Laoniawan, the community grew into a walled village.

Along the road from Laoniawan village to Deshengbao Fortress (Fig. 2) are sited lots of similar settlements, at a distance of about 20 km from each other. That is why they had a defensive role, forming part of the fortification system of the Great Wall, having been built during the Ming dynasty (Knapp, 1992; Linfeng Wang, 2018). This is a widespread defensive system in northern China, from the coast in northeast of Hebei into the Yellow River meander areas, among Inner Mongolia, Shanxi and Shaanxi, an area along the Great Wall known as Great Wall Rural Settlement Region.



Fig. 2 Great Wall Rural Settlement Region: area from Laoniawan village to Deshengbao Fortress. Walled villages area showed with a star

In the late Warring States Period (476 BC-221 BC), many ancient states (Han, Zhao, Wei, Yan, Chu and Qi) built their own defensive wall along their borders to prevent attack from other states. When Qin state conquered those six states, creating the first empire in Chinese history, the different wall sections were put together.

Since then, every dynasty repaired and reinforced the Great Wall until Ming dynasty. Thus, this military defense system consisted not only of the long defensive wall, but also of beacon towers and military settlements where troops were placed.

More precisely, at the beginning of the Ming dynasty, the preliminary role of those settlements was to prevent invasions of northern nomadic tribes. While, in the central period of the Ming dynasty, the commercial function increased. When the Qing dynasty took the place of the Ming dynasty, these fortresses totally lost their military function and became rural villages. Their earthen high walls were partly abandoned having lost their defensive role. Unfortunately, today most of those structures are partially destroyed or disappeared. Nonetheless, in most of the villages' current name is present the word "bao" or "pu" that means it was a defensive castle and "cun" means that it is now a common village.

### LAONIUWAN VILLAGE

Today, Laoniawan's historic urban landscape still shows the traditional morphology (Fig. 3). On the top of the hill, the ancient castle walls, made of earthen masonry, are still there in a very poor state (Fig. 5-6). The watchtowers, along the walls, are in pretty much the same state of conservation and so are the keeps on the south side of the wall. The towers were about several hundred meters apart, truncated square pyramids in shape, each one surrounded by a smaller wall, probably constituting the barracks of the Ming soldiers. The main entrance is surrounded by a tower, realized by mixing earthen and local stone.



Fig. 3 Laoniuan village map (A. D'Eredità)

Inside the fortress, one may observe the ancient beacon tower, made of stone basement and fired bricks masonry, which has been used as a granary in modern time, and few dwellings in yaodong (窑洞) style - i.e. with structures dug or



semi-hollow in the ground -, built with few bricks from the walls of the fortification itself. Furthermore, walking on the edges of the rocks contouring the gorge, on a hill about 5 or 6 km NW from Laoniawan, there is a temple area.

Lower down, at the foot of the wall belt, following the irregularity of the topography, some cave dwellings were excavated into flanks of elongated ravines, together with farming terraces, and here there are also stone walls remains subdividing each property (Fig. 4), composing a very peculiar urban shape.

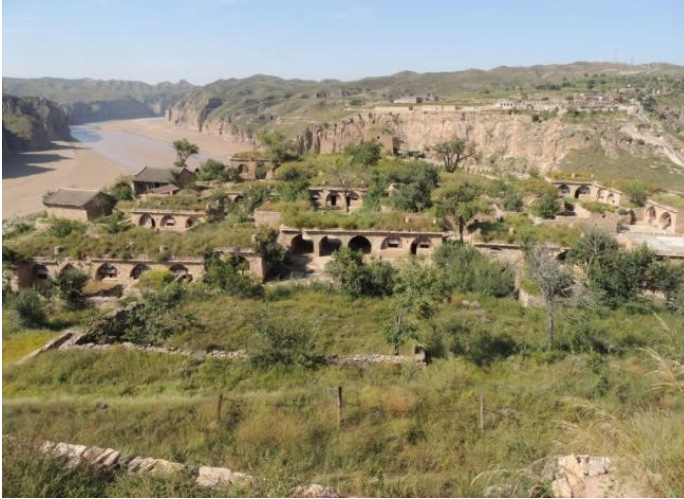


Fig. 4 Laoniawan village, a general view of yaodongs



Fig. 5 Laoniawan Fort remains



Fig. 6 Laoniawan Fort remains

Those cave spaces have varied functions, constituting the minimal unit of innumerable rural villages (Genovese et al., 2019). Depending on the subsoil geo-morphology and the geo-climatic conditions, yaodongs have a variety of plans, sections and details, representing the very expression of the technical skills and traditional culture of the Loess Plateau region (Golany, 1992). This is an area of almost 640,000 km<sup>2</sup>, covering most parts of the provinces of Shanxi and Shaanxi and it extends into parts of Gansu, Ningxia, and Inner Mongolia. The plateau is characterized by slopes, ridges and valleys, with a very fine and loamy terrain that is highly fertile and easy to dig (Kapp, 2015). Despite the easy erodibility, these terrains have the characteristic of being pseudo coherent, i.e. they can be excavated and the cavities are more or less self-sustaining like in the case of volcanic tuff. Moreover, thanks to the pseudo coherent characteristics acquired by mixing with water and then dried, loess has been the material used to build locally the different portions of the Great Wall, fortresses and dwellings according to a particular technology.

Generally, a yaodong is a kind of artificial cave shaped like a long vaulted room, with a semicircular entrance closed by walls, made of earthen bricks, stones of wood, and covered with a wooden door or a quilt. This arch-shaped structure provides the entrance to the dwelling, allowing the sun to penetrate further inside the cave even in winter, therefore making full use of solar radiation. A thick layer of earth on top (about 3 to 5 meters deep) acts as an effective insulation coverage and humidity modulator. Above a yaodong, there are often little chimneys and a tunnel constructed in the earth, representing the breathing system of a yaodong. The inner space has usually a mixed use: the main living room works as well as the kitchen and sometimes

the bedroom. In fact, the brazier for cooking also works as heating for the environment and for the adobe brick bed (*kang*) attached to it. While the toilet is outside of the cave, as an individual unit.

Furthermore, Laoniawan village has different typologies of yaodongs, as semi terrain and independent ones. This last typology - *hoop yaodong* (*gūyáo*) - represent a very local type, having a chamber almost all above ground with an arched structure inspired by the underground dwellings, and facing in a courtyard. This arch-shaped structure realized in stone, and covered with an earthen plaster for thermal insulation purposes, also provides the entrance to the dwelling. Walls are built with earthen bricks and/or stone flakes, while roofs are made of stone flakes covered with earth, to ensure the thermal insulation of the interiors.

Those types of yaodongs depend on ground morphology: the presence of the bedrock exposed on top of the hill makes excavation somewhat difficult and motivates the construction of houses wholly above ground, while if these insist on the slope of the hill they are partially excavated.

Usually multiple dwellings are built adjacent to or on top of one another and connected together to form a multi-tiered village, often for a single clan or an extended family. Terrain and semi terrain elements are combined with structure built above ground in order to form an integrated complex connected by path (Knapp, 2000). Nonetheless, dwellings are hidden in the environment, being perfectly integrated into nature with minimum impact. However, they are very fragile: earthen architecture is subject to rapid decay processes, particularly suffering the humidity, thus needing daily maintenance.

## EARTHEN WALLED VILLAGES AND CONSERVATION ISSUES

In Laoniawan village, the main activity of the dwellers was farming, and they were isolated from the rest of the world. In recent years, many of the residents have moved to big cities in search of work. Now, very few people still live in Laoniawan village. In recent years, the Government has planned the reconstruction and restoration of vernacular structures using local materials and traditional knowledge to reuse these dwellings with the goal of local development through a sustainable tourism. Laoniawan has been faced with the challenge of not losing its vitality, safeguarding its environment and culture, by attracting tourism.

Nonetheless, the conservation problem still remains. Rammed earth is the main construction technique of the large rammed earth mound walls that encircled villages in the Shanxi Province. Rammed earth is a construction technique where the soil is taken from the ground and compacted to form structures. Removable formwork is installed, and the soil compacted within it. This technique was widely used in ancient constructions. The term "hangtu" is used by Chinese archaeologists to describe both rammed earth mounds and earth rammed between formwork (Jaquin,

2008). For earthen sites, exposed outdoors two main deterioration factors can be distinguished: natural and human. The human factor is due to technique of construction and engineering-related properties of the materials selected to build the site. The natural factor is due to rain, wind, solar radiation, mudslides, biological action etc. and they cause physical and chemical weathering (Li, 2009; Wang, 2004; Li, 2011; Du, 2017).

Chemical deterioration is mainly due to enrichment of soluble salts that cyclically dissolve and crystallize leading to the destruction of cohesive forces and the erosion of earthen material. Physical weathering is erosion by wind and rain. In arid climates, precipitations are generally low but heavy, they contribute significantly to erosion, as they soften and disintegrate the earth. Especially in summer season, the high temperature promotes a high evaporation rate of the water leading to quickly drying the earthen surface and turns the softened earthen material into scale like crusts, which fall off under the combined action of wind and rain.

The following types of decay can be observed in earthen structure: erosion, exfoliation, honeycomb, scaling off (Cui, 2019), sapping, gulling, cracking, collapse and biodeterioration. Among these types of deterioration, exfoliation, cracking and erosion are the most frequent because wind and severe rainfall are the main impact factors of decay. All these types of decay mechanisms can threaten the stability of the earthen site.

According to the "Principles for the Conservation of Heritage Sites in China", conservation intervention refers to all measures carried out to preserve the physical remains of sites and their authenticity. The conservation involves the identification and investigation of heritage sites for determining the values of a site, its state of preservation, and its management context through analysis of historical documents and on-site survey. Only if because of the previous investigation the site is formally proclaimed as an officially protected entity the preparation of a preservation master plan is carried out. The first step of the conservation practice is the routine maintenance to slow deterioration and only if the site is considered at risk of heavy damage the "minimal" conservation intervention is planned (Agnew, 2002).

The consolidation techniques for earthen sites include surface consolidation (Li, 1995, 2009, 2011; Zhou, 2004; Wan, 2012; Zhao, 2016; Wang, 2016), grouting, mud bricklaying, anchor bamboo or wooden rods, and building a new wall where the wall collapsed.

In the area of the walled villages investigated in this contribution, the remains of the rammed earth walls are affected by various climate-related conservation problems. In fact, in the area the rains are few but intense. Most of the rain falls in the summer period, in two months, when the temperatures are very high with consequent rapid evaporation, which leads to the formation of cracks, exfoliation, honeycomb, sapping until the collapse of the foundation. The dry but very windy winter favors a strong superficial erosion. In addition, the presence of vegetation favors phenomena of disintegration.

These problems, together with a total lack of maintenance, are leading to the complete destruction of the rammed earth walls of the villages. Therefore, an immediate action is necessary both to assure structures at risk of collapse and to preserve existing structures with surface and structural conservation methods with attention to the construction of drainage systems for rain.

## CONCLUSIONS

The conservation and enhancement of the earthen military villages should be associated with the protection of the rural landscape as required by the Venice Charter (1964, article 1) which underlines the concept of conservation of historical monuments but also the urban or rural setting in which is found the evidence of a particular civilization. In recent decades, the Chinese government has paid much attention to the protection and restoration of the Great Wall and has implemented the "Great Wall Protection Ordinance" in 2006, which outlines actions concerning natural factors and human activities that seriously threaten the structure of the Great Wall (last updated on 22 September 2017).

Tangible results of this activity are highlighted in the village of Laoniawan located near the Great Wall in Shanxi Province. Furthermore, the series of Ming dynasty military settlements, whose inhabitants are currently farmers, have not received the same attention or only in some cases, there are examples of projects for the conservation and maintenance of the characteristics of their vernacular architecture.

A reasonable solution should be a common strategic plan for conservation projects and reconstruction of earthen walled settlements that takes into account the entire minor sites as well as the rural landscape. Only this more global vision will allow local development by promoting awareness among the inhabitants of local villages of the intrinsic values of their heritage. The Sino-Italian collaborative research still ongoing by the authors on vernacular earthen villages, about which some results are reported in this paper, aims at evaluate possible solutions for conservation and sustainable enhancement of structures and landscapes.

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