

## Discussion on Technology and Methods of Ancient Architecture Surveying

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**Abstract**—By combining with surveying examples of ancient architecture, according to different architecture properties, the importance of ancient architecture surveying is illustrated. Besides, methods and practice of ancient architecture surveying are studied, and current situations and problems of ancient architecture surveying are analyzed. Moreover, relevant countermeasures are sought and ancient architecture surveying experience and methods are summarized. Finally, some new thoughts are proposed.

**Keywords**—*ancient architecture; surveying; technology; method*

Ancient architecture is the cultural heritage of a country and nation as well as a carrier of historical tradition for a country and nation. Ancient architecture surveying is the basic link of protecting, exploring, systemizing and utilizing excellent architectural heritage of ancient times, and it will provide scientific record for architectural heritage protection. Due to ancient architecture surveying, the protection work can be scientifically and effectively carried out. At the same time, detailed and accurate fundamental data are provided for architectural history and theory research as well as architectural history teaching, and references will be offered to inheritance of traditional architectural culture and exploration of modern architecture creation with Chinese characteristics. Ancient architecture surveying is both a method and process of learning and study.

### I. FUNCTION AND SIGNIFICANCE OF LEARNING ANCIENT ARCHITECTURE SURVEYING

Any academic research comes from practice and meanwhile it also participates in and guides practice, especially subjects with strong applicability and practice like architecture. The function of practice is to summarize the learned knowledge to some degree as well as to deepen the perceptual cognition about the function of learned knowledge in practice and the understanding about ancient architecture.

Ancient architecture surveying means to survey and investigate architectural entities, to grasp basic contents and methods of architectural research, and to cultivate the independent working ability and teamwork spirit in investigation. Meanwhile, as detailed and accurate fundamental material of architectural heritage protection, research, development and utilization, surveying achievement can cultivate rigorous working attitude and sense of social responsibility.

By studying ancient architecture surveying, perceptual cognition about traditional experience of Chinese architecture can be enhanced. Moreover, we can also deeply understand, consolidate and flexibly utilize basic theories, knowledge and skills of Chinese Architecture History, History of City Construction, Architectural Surveying, Projection and Drawing, Architectural Design Foundation, and Computer Mapping. Furthermore, cognition and theory about excellent architectural heritage of ancient China can be deepened and enhanced. Besides, we are able to personally turn architectural entity into engineering drawing and data information according to a certain proportion, grasp surveying methods, and deepen our understanding about architectural image and building method.

### II. MAIN CONTENTS OF ANCIENT ARCHITECTURE SURVEYING WORK

Ancient architecture surveying means to measure the shape, size and spatial position of buildings as well as to draw corresponding plane graph, elevation and profile map on the basis of measurement. It is direct application of surveying science to architectural heritage recording, monitoring and protection engineering implementation in cultural heritage protection field. In technology, it belongs to the category of engineering surveying which is a branch of surveying science. However, surveying technology is just means, rather than the complete part of ancient architecture surveying. It covers experience, cognition, understanding, even exploration, screening, discovery and evaluation of architectural heritage in science, humanity, technology and arts, and includes comprehension, representation and expression of architectural entities, space and spiritual implication. It contains value judgment and information screening, rather than passive depiction.

Finally, we will learn to draw surveying map. Firstly, we need to study the requirements, rules, essentials, and AutoCAD advanced skills of computer graphics as well as common skills of ancient architecture drawing. Secondly, AutoCAD drawing will be carried out with the acquired data, so as to further deepen the knowledge and skill about ancient architecture surveying. Systematic and streamlined processing will be conducted for the collected surveying data and images.

### III. INTRODUCTION TO VARIOUS SKILLS AND METHODS OF ANCIENT ARCHITECTURE SURVEYING

The existing ancient architecture surveying methods include manual measurement with flexible rule, electronic

total station, digital close shot photography measurement, and three-dimensional laser scanning system.

Manual measurement is the most common, direct and effective way, but meanwhile it is also the most toilsome method. In fact, most measurement problems are converted into distance measurement, and flexible rule is mainly used to carry out distance measurement and simple height measurement. Planar location is conducted via rectangular coordinate method or distance intersection method.

Electronic total station is the measurement equipment that integrates distance measurement, angle measurement and altitude difference measurement together. The basic function of electronic total station is to measure horizontal angle, vertical angle and slope distance. With the help of solidified software, multiple measurement functions can be combined. For instance, the three-dimensional coordinate of horizontal distance, altitude difference and mirror site can be calculated and displayed, and eccentricity measurement, remote elevation measurement, opposite side measurement, and area calculation can be carried out.

We should try to survey maps or drawings of ancient architecture via digital close shot photography method and three-dimensional laser scanning system as far as possible by starting from the engineering purpose of ancient architecture surveying. It is the most suitable and ideal method for ancient architecture protection, maintenance and reconstruction works. Meanwhile, it cannot be replaced by other methods and working performance can be improved. However, due to the high cost of instrument, complexity of technology and problems of measurement environment, it is seldom applied to most ancient architecture surveying works.

#### IV. MAIN PROBLEMS AND SOLUTIONS IN THE PROCESS OF ANCIENT ARCHITECTURE SURVEYING

##### A. Current situation and problems of ancient architecture

Due to long-term load, differential settlement of the foundation, difference of materials, and influence of natural factors, components will undergo deformation like contraction and bending as well as damage of some parts, such as collapsed eaves, submerged corner post, cracked column, bended beam, slanting and submergence of beam frame, cresting with a part falling, and only one remaining main ridge decoration.

##### Solutions:

**Deformation and destruction with great influence on the structure:** Corner part of the building will deform easily, for this part has complicated structure and multiple components. Moreover, it is prone to external load, so the eave angle will collapse. Corner post bears heavier load of eave angle when compared with other peripheral column; besides, differential settlement of the foundation exists, so it is easy to submerge. Under such situation, surveying should be conducted according to the original state. Several similar components can be selected for measurement and comparison and the most frequent

numerical value should be chosen as uniform size of such components. Average value of these sizes should not be used as the uniform size. Moreover, original size of the components can be calculated and verified according to modulus relation.

For example, in terms of collapsed eave angle, we can observe which key components have problems and then recover them according to the normal structure. Recovery of corner post height can be conducted according to the height of other peripheral columns. If there is any rise, the rising size should also be added. Recovery for structure must be taken down in detail in the drawing illustration of surveying report.

**Deformation and destruction without great influence on the structure:** Missed components, bended parts, cracks, fuzzy patterns and washed-out color paintings will not affect overall stability of the architecture, so surveying will be conducted according to the current situation, so as to truly express the existence of ancient architecture and maintain its sense of history and sense of time.

##### B. Problems of size

**Disunion of overall size and sub-size:** Sizes of various components separately measured are inconsistent with the overall size. For instance, the sum of standard widths is greater than the general width, and the height sum of components at different layers of beam frame is greater than the total height of beam frame.

**Disunion of size among similar components in corresponding positions:** For instance, the diameters of two hypostyle columns are different; section sizes of girders with the same structural functions in the same position of beam frame vary; sometimes, standard widths in symmetrical positions along the central bay are different.

##### Solutions:

**Secondary size obeys main size:** Main size can decide and influence shape, height and period style characteristics of architecture, such as standard width and depth; column height and roof truss height in beam frame; projection in bracket set. Secondary size refers to size that has no close relation with the entire framework of architecture or that can be worked out via indirect methods, such as sill box length of doors and windows, and thickness of wall.

**Sub-size obeys overall size:** The extra figure of a certain part or component should be found out as far as possible, and this figure must be subtracted from the sum of sub-sizes, so as to make the sum of sub-sizes equal to overall size.

**The minority obeys the majority:** The uniform size of the same components in architecture should be determined according to the principle of the minority obeying the majority, such as projection in bracket set, length of arch, and size of bracket. The average value of majority sizes should never be used to determine the uniform size.

**Size marking:** If sizes of similar components are at the same side of the components, they should be marked at the same direction, and sizes of different components can be marked along the same building axis (center line of column).

**Replacing components obey original components:** Original components in various parts of the architecture should be measured, so as to determine the uniform size. The uniform size should not be determined by taking the most frequent size of a certain component or the size of a well-preserved component.

#### V. DRAWING EXAMPLES OF SURVEYING RESULTS

Surveying results mainly include plane graph, elevation, profile map, detail drawing and relevant auxiliary cultural relics.



Figure 1. Detail drawing for the third courtyard of Chunyang Palace surveying

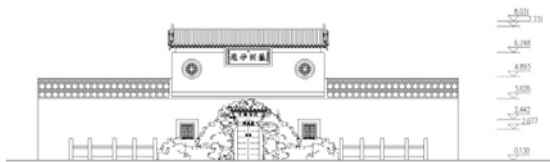


Figure 2. Elevation for the third courtyard of Chunyang Palace surveying

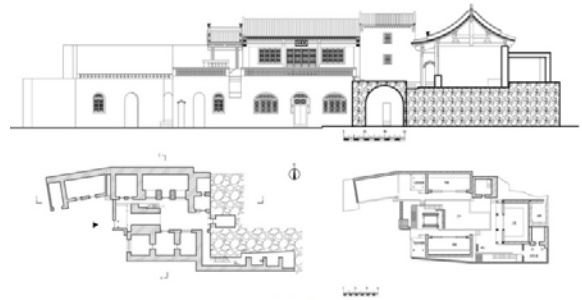


Figure 3. Plane graph and elevation for Zizhulin Temple of Diantou Village

#### VI. CONCLUSION

In order to complete the ancient architecture surveying work, surveying people should grasp basic principles and methods of surveying as well as provide close cooperation and collaboration for surveying workers. The more familiar you are with structure of ancient architecture, the more exquisite the measurement work will be and the more accurate the conclusion will be. Modern surveying technology should be organically combined with traditional ancient architecture measurement methods, and the basic concepts, basic principles and basic methods of surveying must be updated continuously, so as to better adapt to development requirements of different majors.

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