RESEARCH ON THE RELATIONSHIP BETWEEN ARCHITECTURAL DECORATIVE PATTERNS AND THEIR CARRIERS BASED ON ANALYTIC HIERARCHY PROCESS

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ABSTRACT

Architectural decoration is not only a constituent part of architectural style, but also a connotation expression of the diversity of architectural culture. There is a multi-level relevance between the subject matter, modeling and implication of architectural decoration pattern and architectural type, space and units. The related research is an important supplement to the systematic research of traditional architecture. In view of this, on the basis of detailed investigation and surveying of the research specimens, analytic hierarchy process (AHP) is applied in this study to divide hierarchy of the decorative patterns and the architectural identity, compares the weights of the relevance between the hierarchies, clarifies the complex relationship between the decorative patterns and architecture, and studies the architectural form and its cultural connotation from the architectural decoration.

KEY WORDS

Carrier of architecture, Decorative pattern, Relevance, AHP

1. INTRODUCTION

Architectural decoration is not only an constituent part of architectural form and style, but also an expression medium of architectural culture and regional characteristics. It is an important content of systematic research on traditional architecture and its culture. Nowadays, substantial amount of traditional architectural decorations are going through rapid destruction and disappearance due to dereliction and weathering erosion. After renovating, the architectural decoration forms are also deviating from the historical original to varying degrees. The current situation does not warrant optimism.

The academic circles have carried out corresponding researches on the field of architectural decoration and decorative patterns: (1) the researches of the classification and composition, as well as approaches of decorative patterns in the field of design science [1] [2]. (2) In the field of architecture, most of the discussions of decorative patterns could be found in the historical data research, but more of them remain confined in the introductory level, the deeper overall researches are scarce. Furthermore, there are researches on the aesthetic form of decorative patterns, guided by pattern theories and composition theories [8] [9]. However, there is no systematic coverage to the study of the correlation between decorative patterns and carriers. The

styles of decorative patterns not only have their own morphological systems, but also show specific styles in different carriers, which not only enrich the pattern form systems, but also play important roles in the performance of the carrier forms.

Through long-term research process, it is found that architectural decorative patterns are characterized by rich architectural carrier types, numerous decorative patterns in carriers, miscellaneous detailed decorative patterns and various influencing factors, which are also common problems encountered in the research process of architectural decorative patterns. With "the research characteristics of specific solutions to specific problems", the analytic hierarchy process (AHP) satisfies the research needs of a large number of individual analyses in the study of architectural decorative patterns. Introducing AHP for analyzing architectural decorative patterns from a comprehensive and subtle perspective, can fully reflect the logical relationship between architectural carriers and architectural decorative patterns.

In view of this, the analysis method of AHP is adopted in this research to classify, split and compare the decorative patterns and building carriers, so as to analyze the multi-level relationship between the decorative patterns and the carriers in detail.

2. ARCHITECTURAL DECORATION PATTERNS AND CARRIERS

Definition of pattern by Mr. Lei Guiyuan is: "Pattern is a way of conscious creation performance based on a certain idea to deal with the shape, color, graphics and so on, in order to cause the aesthetic feeling of the audience" [1]. Based on Mr. Lei Guiyuan's definition of pattern and the morphological relationship between pattern and architecture, interpretation of the architectural decoration pattern in this paper is: Based on the architectural form, the shape, color, graphics and other elements are processed to form a pattern form that is consistent with the architectural form, and at the same time, which would help to express the connotation of architectural culture.

Through extensive field research by the research group of traditional architecture and decorative patterns, it has been learned that: architectural decoration pattern not only covers the three basic elements constitute patterns: shape, pattern, color[2], but also subject to the constraints of the carrier, and there is a close relevance with the carrier. According to their form, the approaches of different building units displaying their decorative patterns vary from each other; even the same type of buildings display different styles of decorative patterns due to the different construction years; the same decorative pattern on different scales of the same kind of building units present in different forms; with different types of carriers, the form of patterns differentiate from each other; different types of architecture adopt different patterns. These kinds of phenomenon all reflect a rich relationship between architectural decoration patterns and architectures. Religious architectural decoration patterns are mostly to preach doctrine as the main idea; Residential architectural decoration patterns are mostly reflecting the people's aspirations of the construction age; official architectural decoration patterns reflect the supreme right of those in power.

3. ANALYSIS METHOD

3.1. Analytic Hierarchy Process

The analytic hierarchy process (AHP) originated from T. L. Saaty, a famous American operations researcher and professor of the University of Pittsburgh. In the 17th century, with the emergence of enormous data, it became a problem that factors cannot be expressed

quantitatively, which brought great inconvenience to decision-makers. analytic hierarchy process was meant to solve this problem. In China, AHP has extensive; it has been widely used in economy, policy making, management, project planning, engineering and other fields. Analytic hierarchy process has the characteristics of strong practicability, flexibility and operability, which can simplify the complex and large amount of complex problems. [③] In the study of the relevance between architectural decoration patterns and architectural carriers, the biggest challenge is the large amount of data, the miscellaneous types of architectural decoration patterns, and the various types of traditional building units, which increase the difficulty of the research on their relevance. By using the analytic hierarchy process, through the split and quantitative analysis of the "targeted factors", the research goals are matched one on one correspondingly, and the relationship between the architectural carriers and the decorative patterns reflected in the current status of architectural decoration as well as the application rules are clarified.

3.2. Process Analysis

The application of analytic hierarchy process to analyze the research object, first of all, the different factors of each problem are broken down into: target layer, guideline layer and scheme layer. Through the weight comparison between the hierarchies to conduct analysis and comparison. Using analytic hierarchy process to study the relevance between the architectural decoration pattern and its carrier, the relevance can be set as the overall goal, the architectural carrier unit is set as the guideline layer, the decoration pattern is set as the scheme layer, and the weight calculation is calculated according to the upper and lower containment relationship between the elements. The analysis process includes: 1. Establishing the scale hierarchy of the problem; 2. Constructing one on one judgment matrix; 3. Calculating the relative weight of the elements being compared by the judgment matrix; 4. Calculating the combined weight of the elements of each layer; and 5. Performing the consistency test [5].

Through the establishing of hierarchical structure, the index evaluation of architectural unit hierarchy and decorative pattern hierarchy is carried out, and comparison of weight for evaluation indexes of different hierarchies is made. The weight was reflected by the scaling of "1-4" (1: not important, 2: important, 3: very important, 4: extremly important), and the matrix of one on one weight comparison was formed. Calculating the weight of architectural unit hierarchy and decorative pattern hierarchy index (Wi), as well as the factor quantity order (n) of architectural unit hierarchy and decorative pattern hierarchy, and judge the maximum eigen value of matrix X. The calculation formula is as the following (1):

$$\omega_i = (\prod_{j=1}^{m} X_{ij})^{1/n} / \sum_{i=1}^{n} (\prod_{j=1}^{n} X_{ij})^{1/n}$$

$$\lambda_{max} = \sum_{i=0}^{n} (X\omega)_i / n\,\omega_i$$

(1)

Through geometric averaging and normalization processing of the characteristic vectors of each row of the judgment matrix, to obtain the weight vector w corresponding to the architectural unit element and the decorative pattern element:

$$\omega = (\omega_1, \omega_2, \omega_3, \omega_4, \ldots \omega_n)$$

Compare the results for consistency to obtain the consistency index CI. Use the consistency index and the random consistency index RI to calculate the consistency ratio CR. The formula is (2):

$$CI = (\lambda_{max} - n)/(n - 1)$$
$$CR = CI/RI \qquad\qquad (2)$$

When consistency test result CR is smaller than 0.1, it passes the consistency test. In addition, when the values of n in the formula are equal to 1, 2, 3… 9, the random consistency index values are 0, 0.52, 0.89, 1.12, 1.24, 1.32, 1.44 and 1.45respectively.

When the calculation results pass the consistency test, it is proved that the weight values of the above-mentioned indexes at all levels are established, and the factors with high weight values are of higher importance to the research subject. On the contrary, the importance is low. In this approach, the relevance and degree of relevance between the architecture carriers and the decorative patterns are obtained.

4. APPLICATION OF RELEVANCE RESEARCH BASED ON ANALYTIC HIERARCHY PROCESS: A CASE STUDY OF THE LONGSHENG ZHUANG RESIDENTIAL AREA

4.1. Overview of Longsheng Zhuang

Longsheng Zhuang is located in Fengzhen City, southeast of Ulaanchab City, Inner Mongolia, China. It is one of the earliest market towns in Ulaanchab area. In the year Qianlong 12 (AD 1747), the recruited landless farmers from Shanxi, Hebei and Shaanxi were settled here [12], [13].Longsheng Zhuang traditional village is a rare traditional village in existence with a relatively large scale and a more complete system in Inner Mongolia. Its residential buildings are large in number, rich in variety and with exquisite decoration (figure 1). Longsheng Zhuang was named as the first batch of National traditional villages in 2012 and the sixth batch of famous Chinese historical and cultural towns in 2014. The traditional residential buildings in Longsheng Zhuang area are rich in decorative patterns and well preserved (Table 1). Taking the traditional residential buildings in Longsheng Zhuang area as an example, AHP is adopted in this research to study the relevance between the architectural decoration patterns and architectural carriers of traditional residential buildings in Longsheng Zhuang district.

Fig.1The full view of Long shengzhuang

Table 1. Status of Longsheng village dwelling house decoration

Building unit	Gable front	Lintel	Door panel	Rooftop etc.
Status of architectural decoration				

4.2. Analysis of the Relevance Between Architectural Decoration Patterns and Carriers

Based on extensive on-the-spot investigations on the traditional residential buildings in Longsheng Zhuang, combined with the decomposition of the relevant characteristics of the decorative patterns, this research sort outs the characteristics of the relevance between the architectural decorative patterns and the units from the aspects of the architectural units and the architectural decorative patterns, and set it as the basis for the selection of indexes, and revises the index system by taking into account of the opinions of the local residents and relevant scholars to establish an relevance characteristics evaluation index system of the architectural decoration patterns and building units in accordance with the actual situation of Longsheng Zhuang residential complex.

The indexes in the basic characteristic evaluation index system is graded on the relevance scaling of 1 to 4, and one on one comparison are given to determine the close degree of relevance between the factors, and the weight of the indexes at all levels is calculated（Table1.2）.

Table 2. Primary evaluation index questionnaire for the relevance between architectural decorative patterns and carriers in Longsheng Zhuang residential complex

Evaluation index	Characterization	Relevance			
Gable front	Most of them are located on both sides of the house with hard Gables to support the front and back eaves	1	2	3	4
Lintel	Upper part of door frame, lintel	1	2	3	4
Door panel	Main decorative component of the door	1	2	3	4
Rooftop etc	Roof, ableboard, etc.	1	2	3	4

Table 3. Secondary evaluation index questionnaire for the relevance between architectural decorative patterns and carriers in Longsheng Zhuang residential complex

The target layer	Primary index (B)	Secondary index (C)	Characterization of Secondary index	Relevance of secondary index to primary index			
Influence factor of relevance between architectural decorative pattern and carrier in Longsheng Zhuang residential complex (A)	Gable front (B1)	Geometrical pattern (c11)	Line, circle, square, triangle, etc.	1	2	3	4
		Pattern of plants (c12)	Rolling grass, water lily, lotus, etc.	1	2	3	4
		Pattern of animals (c13)	Tigers, lions, bats, etc.	1	2	3	4
	Lintel (B2)	Geometrical pattern (c21)	Line, circle, square, triangle, etc.	1	2	3	4
		Pattern of plants (c22)	Rolling grass, water lily, lotus, etc.	1	2	3	4
		Pattern of animals (c23)	Tigers, lions, bats, etc.	1	2	3	4
	Door panel (B3)	Geometrical pattern (c31)	Line, circle, square, triangle, etc.	1	2	3	4
		Pattern of plants (c32)	Rolling grass, water lily, lotus, etc.	1	2	3	4
		Pattern of animals (c33)	Tigers, lions, bats, etc.	1	2	3	4
	Rooftop and so on (B4)	Geometrical pattern (c41)	Line, circle, square, triangle, etc.	1	2	3	4
		Pattern of plants (c42)	Rolling grass, water lily, lotus, etc.	1	2	3	4
		Pattern of animals (c43)	Tigers, lions, bats, etc.	1	2	3	4

According to the actual condition of the residential complex in Longsheng Zhuang, 4 primary indexes and 12 secondary indexes (with 3 as a group) were obtained. After all levels of indexes are weighted for statistics, the evaluation table is obtained, and the consistency test is performed(Table4.5).

Table 4. Scoring table of the primary index data

Primary indexes	Data values						
	B1	B2	B3	B4	W_i		
B1	1		3.2451		2.4525	3.9653	0.493186137
B2	0.3081		1		0.7634	1.896	0.170048644
B3	0.4077		1.3099		1	3.6477	0.245836893
B4	0.2521		0.5274		0.2741	1	0.090928327
λ_{max}					4.06308512		
CR					0.023627386		

Table 5. Scoring table of secondary index data

Primary indexes	Secondary indexes	Data values				Primary indexes	Secondary indexes	Data values			
		C11	C12	C13	Wi			C21	C22	C23	Wi
B1	C11	1	0.6453	3.3551	0.3855	B2	C21	1	1.2546	2.0546	0.4355
	C12	1.5496	1	3.4314	0.4526		C22	0.7970	1	0.7541	0.2797
	C13	0.2980	0.2914	1	0.1618		C23	0.4867	1.3260	1	0.2847
	λ_{max}	3.079254602						3.068284404			
	CR	0.076206348						0.065658081			
		C31	C32	C33	Wi			C41	C42	C43	Wi
B3	C31	1	2.7562	2.4673	0.5433	B4	C41	1	0.4187	0.3762	0.1761
	C32	0.3616	1	2.0146	0.2647		C42	2.3883	1	0.7891	0.3820
	C33	0.4053	0.4963	1	0.1918		C43	2.6581		1	0.4417
	λ_{max}	3.084537638						3.007002253			
	CR	0.081286191						0.006732935			

According to the above weight calculation value (WI), it can be seen that: among the traditional residential buildings in Longsheng Zhuang area, the most common decorative pattern types on gable fronts (B1) are plant patterns (C12), the most common decorative pattern types on lintels (B2) are plant patterns (C22), the most common decorative patterns on door panel (B3) are geometric patterns (C31), and the most common decorative patterns on rooftops and other structures (B4) are animal patterns (C43). The data obtained by using the analytic hierarchy process are highly agree with the actual situation on the spot, which also proves the decorative characteristics that the architectural decorations of residential buildings are most commonly found on the gable fronts, rooftops as well as doors and windows components, and subject matter of the decorative pattern is mainly plant patterns and geometric patterns. At the same time, the feasibility of AHP in this field is verified by result analysis of the case study.

In addition, by analyzing the comparison data of the weights of all layers of the building units and the decorative patterns, we can obtain that: 1. The frequency of using the same decorative pattern in different units of the same building; 2. The frequency of using the same decorative pattern in the same unit of different buildings; 3. The expression of the same pattern element in different architectural decorative pattern forms and the hierarchical relationship with the architectural carriers (Table 6). Take gable fronts as the example: According to the research data, it can be found that the most commonly used decorative patterns of gable fronts in Longsheng Zhuang houses are plant patterns (with a weight ratio of 0.4526), followed by geometric patterns (with a weight ratio of 0.3855), and that of the lowest frequency are animal patterns (with a weight ratio of merely 0.1618), which reflects the influence of architecture types and units on the use of decorative patterns. Due to the limitation of the class, the decorative patterns of the residential buildings are mainly plants (Figure 2), and even if the decorative elements are the same in the decoration of gable fronts, the decorative styles and expressions of hierarchy relationship of different residential houses are different. Through the analysis of the relevance between the decoration pattern and architecture of the traditional residential buildings in Longsheng Zhuang, the correspondence between the two is clarified to a great extent, which is of practical guiding significance to the renovation and maintenance in a later stage for the Longsheng Zhuang architectural complex.

Fig. 2 The form of plant patterns in Gable fronts

Table 6. Relationship between decorative pattern and architecture

Application of sunflower decoration in different units in the same architecture			
Wall surface	Gable front	Details of decoration	Sunflower
Application of the same unit decoration in different architectures			
Overall view		Detail view	

5. CONCLUSIONS

In architectural integrity studies, the research of architectural decoration patterns can enrich the research content from the subtle point of view. By analyzing the relevance between architectural decoration patterns and architectural carriers, we can clarify the application characteristics of decoration patterns in different architectural types and units. In this research, AHP is adopted to obtain the ratio relationship of relevance between decorative patterns and architectural carriers through the analysis process of deconstruction of the hierarchies, construction of matrix and comparison of weight. Taking the decorations of traditional residential buildings in Longsheng Zhuang area as an example, in this research, the relevance between the architectural decoration patterns and the carriers of traditional residential buildings is specifically analyzed. The analysis results revealed that the research results of the relevance between the architectural decoration patterns and carriers by applying AHP are consistent with the existing situation, which demonstrates that this method is suitable for this kind of research. The introduction of analytic hierarchy process will provide new ideas and approaches for the research of decorative pattern

field, which would have important reference values for the follow-up research of decorative patterns in other types of carriers. The specific numerical results of the study would also provide scientific data and theoretical basis for subsequent decoration development of different types of architecture.

The Figures and Tables in the Research are all Self-Photographed and Self-Drawn by the Author.

Annotation:

1   Lei Kuiyuan: New patterns [M]. Shanghai: National Compilation and Translation House, January 1949. Page 13.
2   Lei Kuiyuan: New patterns [M]. Shanghai: National Compilation and Translation House, January 1949. Page 13.
3   Xu Shubo: A Practical Decision-making Method: Analytic Hierarchy Process [M], Tianjin: Tianjin University Press, May 1988. Page 1

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