Experimental Expression and Logical Deduction of Technology Based on Engineering Philosophy

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Abstract

This paper discusses the concepts and contents of the conceptual origin, evolutionary development and alienation expansion of small experimental buildings, and conducts in-depth analysis and discussion on the current small experimental buildings by centering on the axiology, epistemology and methodology of engineering philosophy, and finally returns to the analysis of the ontology structure technology of small experimental buildings. From the perspectives of axiology, epistemology and the historical, natural and practical views corresponding to the methodology of engineering philosophy, this paper analyzes various representative small-scale experimental building phenomena, and puts forward an experimental direction of small buildings with structural integration as the leading design. From the perspective of ontology of engineering philosophy, this paper further discusses the technical path of system integration of small experimental buildings by using the reductive analysis method of structural components. On this basis, it establishes a clear research system of small experimental buildings under the background of engineering philosophy, and provides directional guidance and specific technical realization strategies for the practice of small experimental buildings. Through in-depth analysis of small experimental buildings with structural integration design method from the perspective of engineering philosophy, the architectural design method guided by structure is established, and the structure is strengthened as the main control factor of architectural form and space, so as to put forward clear direction suggestions for domestic architectural design methods and promote the gradual updating of domestic design methods. Finally realize the social practice value of small experimental building research.

Keywords

Small experimental architecture, structure, engineering philosophy, axiology, epistemology, ontology.

1. Introduction

For any current research on architectural objects, it is faced with an open and complex environment of architectural giant system, and its content is more extensive and profound than before, and it has the dual nature of natural science and social science at the same time, so the road to explore the true meaning of research objects is more difficult and tortuous. This paper chooses small experimental buildings as the research object, tries to discuss them under the

theoretical framework of philosophical category, and distinguishes the conceptual origin, theoretical understanding, design method evolution and thinking expansion of this object from the perspective of engineering philosophy, so as to carry out research on related topics. And finally establish the research vein of small experimental buildings under the technical background. Under the guidance of philosophy, philosophy of technology and the related theoretical framework of the resulting engineering philosophy, this paper will examine the research object of small experimental buildings from different levels and different angles.

The design method evolved from basic construction plays a crucial role in experimental architecture, and is also the most neglected problem in architecture. When we discuss a certain architectural style, school or theory, the process of generating experimental design method is often regarded as the part attached to technology, or the process of technology verification. But from this experimental technology application to look at the architectural form and the trend and direction of architectural development. With the deepening understanding of architecture in recent years, all technical means centering on architecture have received more and more attention, and various experimental construction technical means and design methods have undoubtedly attracted attention. From this perspective, classic cases in the development process of modern architecture and engineering are reviewed through the analysis of corresponding experimental technical means. It will be clearer to see how design methods have evolved and what the future may hold[1].

2. Analysis of the Microscopic Construction of Experimental Buildings - Based on The Morphological Evolution of Construction

Under the scope of engineering philosophy, the discussion on the essence of experimental architecture should be different from the traditional discussion on the form. The discussion on the essence of experimental architecture can be discussed from the “original motivation” under the philosophical category, which can be reduced to the basic connection and structure of the structure at the structural level. The result of this construction extension is to reduce the overall test of the structural system to the basic component construction mode analysis, through which the motivation of the test can be restored. Driven by this “original motivation” based on engineering and structure, the experimental technical route is clearer, and it also shows a more explicit scientific and technical nature. The structural analysis of “original motivation” can be discussed from a more microscopic construction perspective[2].

2.1. Analysis of prototype construction- the concept of “knot”

Although this construction feature dominated the 20th century and remained there for quite a while, during this period, some architects and structural engineers did not fully agree with this theory. They expressed different ideas through their works, and the construction ideas expressed by them were closer to and continued Semper's “knot” theory. These architects and engineers no longer simply regard “knot” as a decorative node, but elaborate the characteristics of "knot" from a technical perspective and from the perspective of space construction. This "knot" has broken away from the concept of two-dimensional weaving and has three-dimensional spatial attributes. As a sublimation of construction skills in this period, the connotation of “knot” has been further enriched. It is no longer a simple combination of industrial standard components, nor a simple weaving of non-structural elements, but the construction of structural elements in the space environment. This construction not only improves the traditional concept of “knot” of Semper in the technical level, but also corrects the one-sided understanding of "knot" in the modernist period. Thus, the theoretical discussion of "knot" is pushed to another technical level based on structural support. From this perspective, the difference between "knot" and decoration is mainly manifested in that starting from the microscopic construction prototype, the structural spatial characteristics of "knot" supporting,

covering and enclosing are expanded in space through structural combination. This process can be regarded as the experimental microscopic expression of structure. As an important part of the structural system, the "junction" is ultimately manifested in the material-based construction transformation, support reconstruction and spatial expansion[3].

2.2. Spatial transformation of the "knot" of the support unit

Some architectural theorists also elaborate on the concept of closure and related construction in their works, just as Adolf Heinrich Borbein argued in his thesis: construction is the art of connection, and this art of connection should be a very broad skill. "Knot" can be regarded as an artistic connection, and this artistic connection can be regarded as an artistic treatment of handicraft in the field of architectural structure to meet the needs of functions. This artistic connection means that the combination and connection of the components of the "knot" are no longer just weaving in the decorative stage, but have a constructive form that reflects various rules, artistic understanding, aesthetic taste and structural theory (Figure 1).

Figure 1. The "woven" gallery frame designed by Balmond

The research of the advanced geometry department on the mutual bearing structural system reflects their further in-depth study on the spatial form generated by the traditional structural units. For such a structural mode that gradually forms a network connection from the basic mutual support, they adopt the combination of the network distribution of structural unit elements, so that the load transfer path forms a complex nested loop. Although this form of structure is not as good as that of a continuous lattice system (Figure 2), there is no problem of bending load transfer between any two structural units of the mutual bearing system, so it can create a structural form of a large span space with more concise nodes[4].

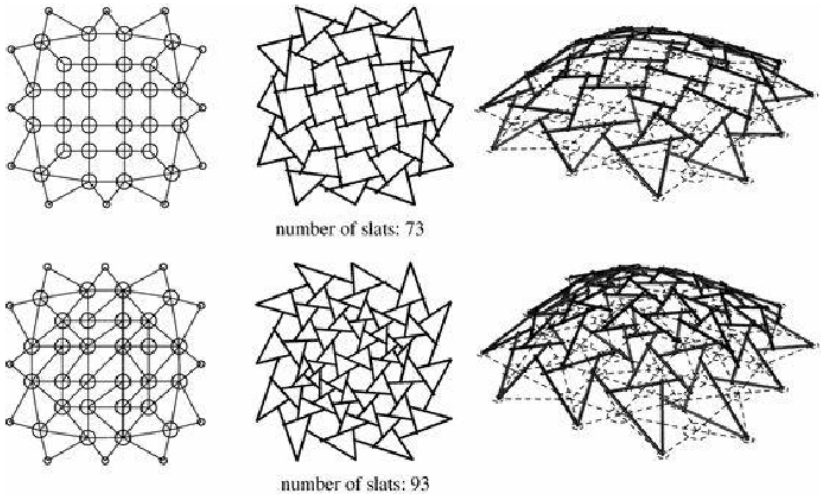

Figure 2. Schematic diagram of the transformation model of the mutual bearing structure

2.3. "braided" form of structural support empty

The above deduction of "weaving" and related design methods is actually a basic morphological analysis based on structural system triggered by "knot". This experiment reflects the breakthrough of the traditional principle of duality in the field of architectural structural design, and further reveals the internal connection, organization rules and derived variation of components in multi-dimensional space.[5] As well as the space construction mode that can not be easily detected by intuitive imagination, the superposition of two grid systems is actually used, and the forces of the two are related to form a hierarchical force transmission route from the bottom to the top, as shown in Figure 3. These practices represented by Balmond show geometric reconstruction with a certain structuralism color, but it is not like the early structuralism philosophy, which is to interpret its own understanding of structure and structuralism from the design method based on the basic component meta-combination, see Figure 3.

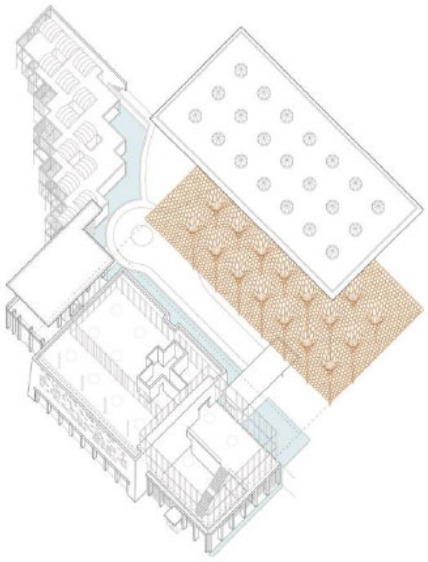

Figure 3. Composite of beam posts, woven mesh and roof covering

3. Influence of the Epistemology of Engineering Philosophy on The Development of Small Experimental Buildings

3.1. Small experimental building expansion that simulates natural forms

Under the guidance of the axiology of engineering philosophy, architects and structural engineers in practice do not simply and directly use the structure as the test carrier, but reasonably intervene from other relevant technical means, and realize the structural transformation under the composite state by combining the actual technical conditions in different periods. This process requires the skillful control of structure and technology, and the technical conditions of engineering intervention corresponding to the transformation between shapes can be found through structural knowledge. In this regard, architects and structural engineers, despite their different professional backgrounds and different understandings of architectural innovation experiment, ultimately maintain the same choice of engineering technical conditions for intervention. Basically, the system value brought by the structural innovation test is shown as the core value of the project, and it is taken as the comprehensive value of the experiment in various historical periods. This stress generates tension on the edge of the shell, making the thin shell seem to be "pulled" towards the shell groin. This small building actually tests the system of compound superposition of two structures at the part that needs to be strengthened by the force, thus achieving a thin shell with abnormally thin edges (Figure 4). From this example, it can be seen that Candela's construction relies on the optimization of technical partial construction to solve technical problems in the engineering process. This seemingly pure engineering technical problem actually contains specific requirements for architectural form optimization and architectural aesthetic orientation, so this architectural experiment is a highly technical composite design expression[5].

Figure 4. Composite superimposed structure formed by general thin shell and reinforced rib

3.2. Structural logic deduction of small experimental building support mode

In the design of Hiroshima Cottage in Hiroshima City, Japan, the main problem faced by the designer at the beginning of the design was how to integrate the building into the surrounding peaceful rural landscape, and how to express this design intention through appropriate structural optimization. Fig. 5 “Unlimited” spatial representation of Hiroshima cottage. The interior of the upper low roof also adopts the grid distribution of I-steel to meet the bearing capacity of the lower wood support as much as possible in light load form, and the double columns on each side form a stable support form with the I-steel on the top. After establishing a simple and efficient support, the interior of the building is divided by a flexible mesh steel wire plate. The use of lightweight materials and the separation of the interior further enhances the sense of transparency between the interior and the exterior. From the perspective of the basic elements of the building, its basic support is to present the true expression of logic in

accordance with the requirements of the structure, while hiding some non-major components to strengthen the expression of the support, and scattering and concealing some unimportant indoor support components, so that the difference between traditional elements of the house, such as walls, Windows and columns, becomes more and more blurred. Finally, an expression of unbounded structural intention is formed[6].

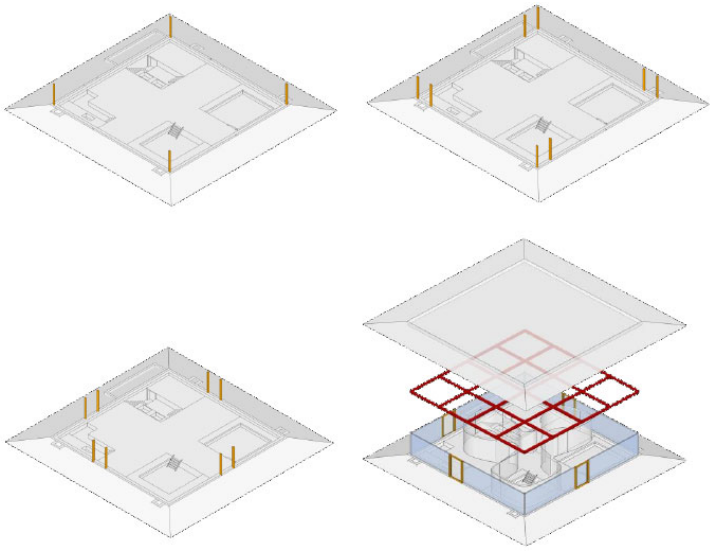

Figure 5. Analysis of the structural composition of the Hiroshima cottage

3.3. The expansion and evolution of small experimental buildings in the form of integrated structures

It can be seen from the above two examples that both are experiments of integrated thinking based on the structural perspective, and the thinking of structural integration shows a simple engineering attribute. The thinking supporting the test development takes elements of the structure such as beams and columns as the basic development conditions, and researches and transforms these traditional supporting conditions through the compound superposition of lateral thinking and lateral thinking. In order to realize the transformation of this traditional condition into a new form under the thinking logic. This kind of thinking based on traditional support reflects the anti-traditional experimental tendency in the category of engineering philosophy, and starts from but is not limited to the constraints of traditional structural logic, thus showing the new alienated support logic of miniaturized experimental buildings[7].

After the decomposition and restoration of this house, it can be found that the process of building space accompanied by the suspension of beams is also the process of the test and variation of beam members themselves (Figure 6). It can be found that the generation of beams, the exaggerated change of vector height, the construction of frame beams and the expansion and application of U-groove beams are accompanied by the application of these beams, which conform to the actual needs of the use of functions. It meets the requirements of local space lighting, private enclosure and residential use, and this process is completely realized through the attributes of the structure, so it is a typical case of thinking expansion and divergence focused on beam construction test[8].

The beam structure test of Horizon House can be traced back to the form application of Le Corbusier's U-shaped roof beam plate in Chandigarh and the gap-vector beam in the Clang Tower in Mises, which have certain similarities in beam structure morphology, but the significance of Le Corbusier's U-shaped roof beam plate symbol is greater than the structural significance[9].

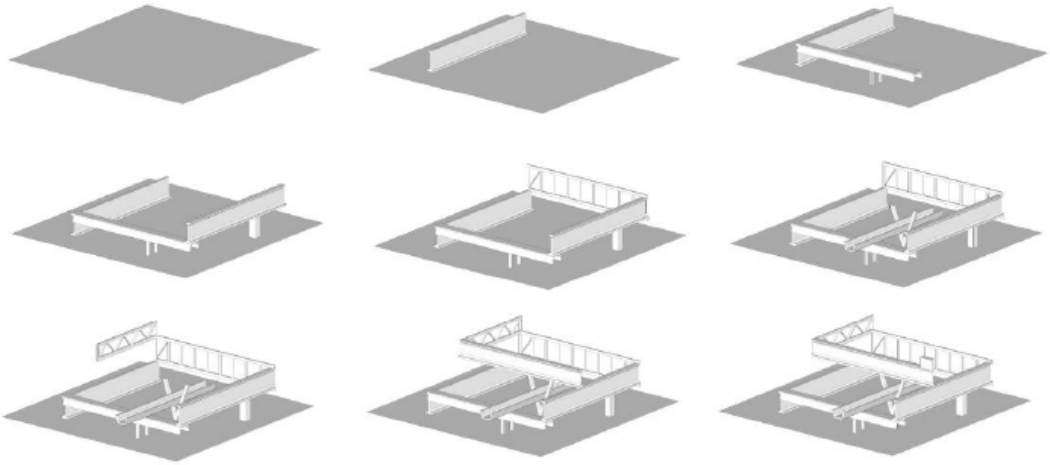

Figure 6. Analysis of the structural composition of the Hiroshima cottage

Through the above case analysis of the integration test, it can be seen that in the process of integration and integration, no matter how abnormal superposition, transformation and displacement of the structural system, as the structure itself is still in the basic state of force balance, balance and the open attribute of the integration test seem to be contradictory to a certain extent. However, as a small experimental building with strong openness, Although openness means breaking the existing balance, a new balance can be found through experiments. The new balance here actually means a new force balance, which is formed through the reasonable evolution of technology, and its balanced form forms diversified manifestations under the support of different technical conditions. Therefore, the dissimilation of balance reflects the pluralism of the integration reconstruction experiment. As can be seen from the above examples, the integrated reconstruction experiment of balanced alienation is still carried out based on structural support. This kind of experiment takes structure as the starting point and foothold of the experiment, and adopts the variation of structural technology as the key link of construction, both of which respond to the design methodology of engineering philosophy, that is, take structural technology as the starting point of design. From the perspective of engineering practice to explore better support performance, support combination form. In the balanced test form, the structure of the design form enters a changeable selection state. Under the guidance of engineering philosophy, this diversified test tendency also needs to be restricted and limited under the framework of technology, so that the alienation of miniaturized balance test will be developed along the line of technology[10].

4. Conclusion

To sum up, this paper analyzes the form of small experimental buildings from the three basic attributes of engineering philosophy

The evolution of design methods is analyzed, and the theoretical origins, construction methods, technology types, material selection and pioneering attributes of these test methods are all involved in the structural level. There are also many differences in the experimental design methods displayed at different stages, which shows that there is diversity in the evolution of design methods in the technical field of small experimental buildings. This diversity is the concrete expression of anti-tradition, pluralism and openness of experimental architecture, which is consistent with the expression of basic characteristics of experimental architecture in chapter 1. At the same time, it should be noted that in these miniaturized experimental designs at different stages, structural components and materials have been re-interpreted and integrated into novel and unique architectural works. However, there are certain differences

between the design methods and the mainstream design methods of the same period, which are directly influenced by the "what is the best design" in engineering philosophy. Under the evolution of the pursuit of the "best" experimental design method, the experimental nature of the structure changes from the local alienation of the building structure to the alienation of the component combination and the system, so that the design method promotes the "impulse" of various experiments in practical engineering. That is, it expresses a kind of starting from the structure itself, and better solving the higher requirements of external factors for buildings through structural means, and also reflects the experimental characteristics of the combination of autonomy and openness of structural design.

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