Systematization of structures and forms of truss systems

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Summary

Many types of trusses have been developed thus far, including the Pratt, Warren, Howe, Fink, K, lenticular, lattice, and Baltimore trusses etc. Although these are all truss systems, each one is usually considered to be different and is dealt with individually. However, from the viewpoint of structure and form, interesting relationships can be found between these trusses.

In this paper, the relationships between the structures and forms of general bridge types are first outlined. Then, the relationships between the various truss systems are discussed. Finally, the various truss systems are systematized with the methods for operations on structures and forms.

Keywords: truss system; form finding; aesthetics of infrastructures; conceptual design

1. Introduction

The space that consists of structures clearly depends on the structure itself. Hence, without an understanding of the structure, it is difficult to gain a sufficient understanding of the quality of the space. Moreover, without a simultaneous understanding of both the structure and the quality of space, an excellent design as a structural art can never be produced. From the viewpoint of the integration of engineering and architecture, it is important to understand the basic principles of structures and forms of bridges to create works of structural art and evaluate them. Moreover, it has been pointed out that it would be useful for young engineers and designers to acquire the skills of conceptual design of structures [1].

This study focuses particularly on the relationships between the structures and forms of truss systems.

Many types of trusses have been developed to date, including the Pratt, Warren, Howe, Fink, K, lenticular, lattice, and Baltimore trusses etc. Although these are all truss systems, each one of them are usually considered to be different and is dealt with individually. However, from the viewpoint of structure and form, interesting relationships are found between these trusses.

The purpose of this research is to clarify such relationships and systematize the fundamental principles underlying them. This would enable us to deepen our understanding of truss systems and conceive new bridge designs. It would also refine the current philosophy behind designing bridges, which are at a meeting point between architecture and engineering.

In this study, as a fundamental model, a truss panel is studied; it is tetragonal and has four sides and four diagonal members. The four sides comprise an upper chord, a lower chord, and two vertical members. The four diagonal members connect the corners of the panel and meet at the centre. The characteristics of the truss panel are examined by transforming the shape of the panel. Two methods are used for transforming the panel: the arrangement of the diagonal members and the transformation of the external frame of the panel. Moreover, additional three methods are used in this study, that is, phase shift, nesting and subdivision. Examinations of the analysis results clarify the fundamental principles underlying the various truss systems. This analysis enables us to

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