NEW CONCEPTUAL DESIGN FOR A TEMPORARY BRIDGE WITH A TRANSFORMABLE STRUCTURAL FORM

Takahiro KISHIMOTO
Civil Engineer(PhD)
KAWAGUCHI&ENGINEERS,
Tokyo, JAPAN
Kishimoto@kawa-struc.com

Takahiro KISHIMOTO, born 1976, received his civil engineering degree from Kyoto University, Japan. He is employed by Kawaguchi & Engineers, Tokyo, Japan. His main area of research is the conceptual design of bridges.

Summary

When bridges cannot be crossed during natural disasters, temporary bridges are constructed as part of emergency recovery efforts to restore road networks, thereby enabling transportation of refuge and relief supplies. Temporary bridges, however, generally have some disadvantages, including lengthy construction times. Their sizes are restricted by the transporting truck's capacity for transformability. In addition, the span length of these bridges is not easily transformable on site. Thus, this paper proposes a new conceptual design for temporary bridges, which is consisted of a design concept and a structural design, to overcome these problems.

Keywords: conceptual design, structural design, temporary bridge, structural form, truss system

1. Introduction

Japan has experienced many natural disasters. As a result, bridges often sustain severe damage, and it is necessary to construct temporary bridges as a part of emergency recovery efforts. These temporary bridges can generally be divided into two categories. In the first category, temporary bridges can be constructed on site from many different parts. These types of bridges involves many processes at the construction site and require a great deal of time and labor to be built. The second category involves transporting temporary bridges that are nearly complete to the disaster site using oversized trucks that have a high level of transformability. In the first type of bridge, standardized units are arranged by the length of the span. For the second type of bridge, it is necessary to prepare some length types of the temporary bridge to adjust to various site conditions. Therefore, it is difficult to arrange the length of the span on site, and many construction materials must be stored. Thus, this paper proposes a new conceptual design for temporary bridges to overcome these problems. The proposed method consists of a design concept and the structural design.

2. Conceptual design

2.1 Design concept

Considering the aforementioned problems, this paper proposes a new design concept as follows:

(1) A flexible structural form that is easy to arrange to lengthen the span of the bridge on site;
(2) Enhanced transportability that can consolidate the holistic form; and
(3) Efficient, simplified construction that reduces labor and the amount of equipment needed.

2.2 Structural form

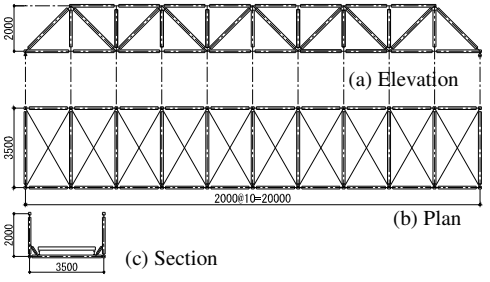

Fig. 1: Structural form

The structural system of a temporary bridge adopts a truss system. The structural form is a Warren truss with vertical members . The floor structure consists of beams and horizontal braces that provide horizontal stiffness. One side is supported by a pin, and the other is supported by a roller pin such that the boundary conditions for the members can be treated as pins. Cover plates are also placed on the floor system.

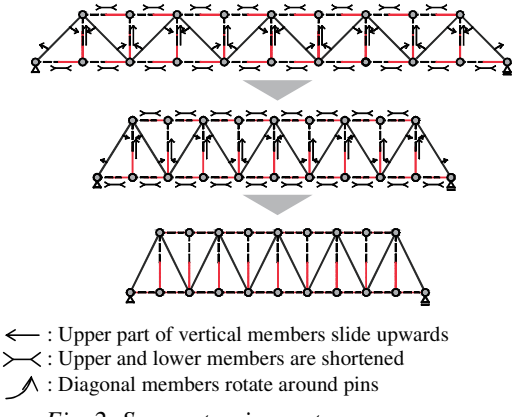

Fig. 2: Span extension system

2.3 Structural design

2.3.1 Extending length of span system

This paper proposes extending the length of the span system to realize a flexible structural form. As shown in Fig. 2, the system allows the vertical members to slide in the vertical direction; the diagonal members rotate around pins, and the upper and lower members slide in the horizontal direction. Thus, the length of the span extends in the longitudinal direction. The system is able to arrange the length of the span on site and reduce the amount of construction materials that are needed to be stored because the temporary bridge can transform to various span lengths.

2.3.2 Consolidating the holistic form system

This system consolidates the configuration of the temporary bridge to make the bridge easier to transport. The length in the longitudinal direction is arranged by extending the length of the span system. In the transverse direction, each beam member consists of two and they are allowed to slide horizontally.

2.3.3 Simplified and reduced-labor construction

The connections of members should be as simple as possible. The extendable length of the span system allows the construction yard to be small. The bridge construction uses a method to launch the structure and suspend the end part. The system reduces labor and the amount of construction equipment needed.

3. Conclusion

This paper proposed a new conceptual design for temporary bridges, which is consists of the design concept and the structural design, to overcome the problems that temporary bridges typically experience. The conceptual design allows a temporary bridge to arrange the length of span flexibly on site, be easy to transport it to the site, and be efficient, simplified construction.