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SCISSORING ORIGAMI INSPIRED DEPLOYABLE BRIDGE FOR A DISASTER

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Summary

In recent years, natural disasters such as earthquakes, floods and tsunamis have caused widespread social damages. For example, many bridges were damaged by a typhoon in 2016 in Hokkaido area in Figure 1(a). We need to develop a new rescue structure to survive these disasters. (I.Ario, M. Nakazawa et. al. 2013) We have to consider how to rebuild damaged infrastructures and how to build a new type of rescue system. Therefore, we suggest a new type of emergency bridge, Mobile Bridge(MB), with a scissors structure that enables it to be temporarily constructed quickly as shown in Figure 1(b) (I.Ario, Nakazawa, M.Tanaka, Y.Tanikura, and Ono, S. 2013). In this paper, we will explain dynamically the calculation method of MB.

Keywords: origami, mobile bridge, emergency bridge, scissors structure, rescue system, strut reinforcement, natural disasters, the restoration of the bridge

1. Introduction

(a) catastrophe of the bridge by a typhoon *(b) design of Mobile Bridge*

Fig. 1. catastrophe of the bridge by a disaster and design of Mobile Bridge

This foot bridge can unfold, and a person can pass after the development(I.Ario 2006). Of course, a car and the emergency vehicle can pass if we increase the size of the bridge. This experimental MB can expand and fold main structural frame, and its characteristic provides rapid construction on site. However, the MB is a flexible structure because of consisting many number of hinge connections. Hence, MB has happened engineering issues such as wind vibration, earthquake shaking, we have to design for them. Therefore, we consider the strut reinforcement to raise more performance of the normal MB. In this paper, we suggest the advanced MB with more stiffness using strut reinforcement of the MB after the expanding and try to build a calculation technique. From the result of numerical simulation, we inspect mechanical property of MB by the reinforcement.

2. Mechanics of scissors structure

FBD of a unit scissors structure is shown in Fig. 2. When the length of the members is L_0 and the expanding angle of inclination is θ, the sectional length λ and height $2h$ are $L_0\sin\theta=\lambda$ and $L_0\cos\theta=2h$. So, the construction and storage of such a structure can be shown by the angle θ.

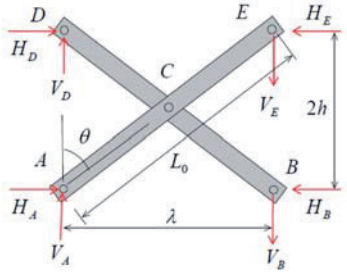

Fig.2. FBD of scissors structure

$$\begin{bmatrix} 1 & 0 & -1 & 0 & 1 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 & 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & \lambda & \lambda & 0 & -2h & \lambda \\ 0 & \lambda & 0 & 0 & 2h & \lambda & -2h & 0 \\ -2h & 0 & 2h & \lambda & 0 & 0 & 0 & \lambda \\ -2h & \lambda & 2h & 0 & 0 & \lambda & 0 & 0 \\ -2h & \lambda & 0 & 0 & 0 & 0 & -2h & \lambda \\ 0 & 0 & 2h & \lambda & 2h & \lambda & 0 & 0 \end{bmatrix} \begin{Bmatrix} H_A \\ V_A \\ H_B \\ V_B \\ H_D \\ V_D \\ H_E \\ V_E \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{Bmatrix}$$

Eq.1. the equations of equilibrium

An unknown reaction force can be solved by thinking about the loading condition and the boundary condition for the equations of equilibrium.

3. Conclusion

The points which became clear from this research are followed as:

- We introduce the equation from equilibrium of force and moment.
- We can expand equilibrium equations as statically indeterminate problem, and lead staticallyindeterminate force and sectional forces based on two analytical examples.

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5. References

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