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A NOVEL CONCEPT FOR A CABLE-STAYED MOVABLE FOOTBRIDGE

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Summary

Movable footbridges can be interesting and feasible solutions to cross waterways when the traffic on the waterways to be crossed is not heavy. They can lower the height in elevation in use, which considerably reduce the effort of the passengers, and also can be spectacular landmarks. In this paper, a novel concept for a cable-stayed movable footbridge is proposed. The concept of geometric design is firstly introduced. The moving mechanism is then shown by means of tracing the opening process. As an essential part of the footbridge concept, the flexible deck which makes use of torsional deformation is introduced. Both static and dynamic analysis of the flexible deck are conducted. The insufficiency in dynamic performance is then discussed. Pre-twisted deck is considered as a possible solution by rising natural frequencies, and with which the performance is shown to be improved according to the result of numerical analysis. Investigation of this innovative concept of movable footbridge highlights new design possibilities for unique lightweight structures with curved configurations.

Keywords: structural concepts; movable structure; prestressed structure; kinematical analysis; generalized inverse; natural frequency

1. Introduction

Movable bridges usually take at least two different phases in their configurations at a crossover point at transportations. The geometry of those movable bridges is able to modify back and forth with time goes, hence they seem to be a sort of four-dimensional structures. Though the recent decades have seen the developments of hydraulic machinery and programmable controllers, maintenance difficulties and expenses are still substantial problems for movable bridges, especially for those using complicated joints. Nevertheless, the story of movable footbridges is far from ending and many still trust their vast potential and varied possibilities. They do not necessarily give the economic solutions but provide fascinating landscapes and bold challenge of engineering. Needless to say, the more interesting configuration and movement the bridges have, the more tourists would be captivated and gather around these new landmarks. In this paper, a novel concept for a cable-stayed movable footbridge is proposed.

2. Design Concepts

The starting structural concept consists in a three-dimensional S-shaped twisting configuration driven by cables. In order to absorb the torsional deformation, the middle part of the deck is showing a remarkable and mysterious curve attracting pedestrians. The moving mechanism is introduced applying the generalized inverse method [1].

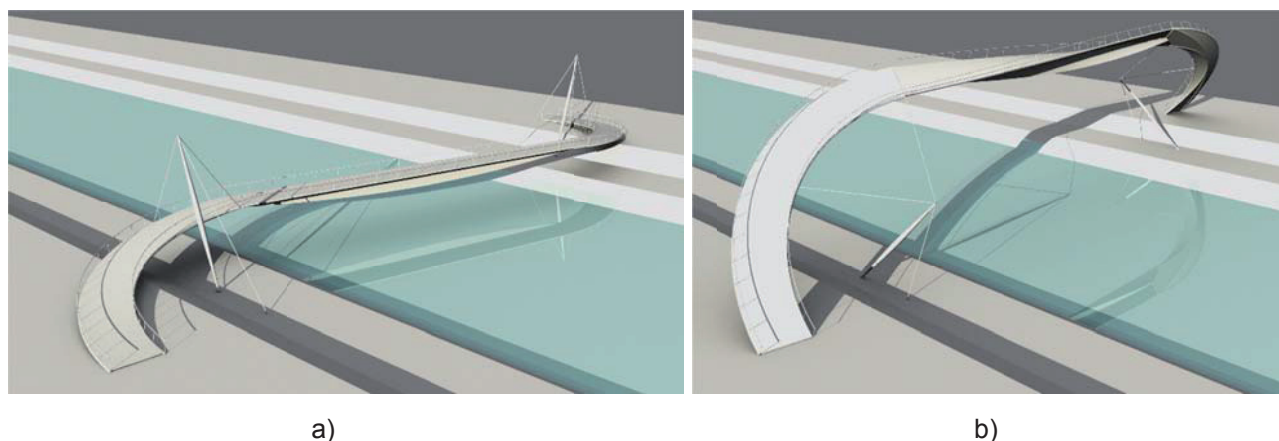


Fig. 1. Concept of the Footbridge, a) In closed state, b) In opened state

3. Analysis of the flexible deck

The utilizing of the elastic torsional deformation of the deck is aimed to design the footbridge without complicated joints or locking device. So that the maintenance reduction appears for the new footbridge. However this leads to a significant contradiction in stiffness of flexible deck of the novel footbridge. In order to clarify the stiffness for external load, the mechanical performance of flexible deck is investigated [2]. The static behavior is satisfied with external loads. Based on the research on vertical bending and twisting. Unfortunately, the special flexible deck seems to be unreasonable according to the natural frequency.

4. Pre-twisted flexible deck

In order to bring improvements in dynamic performance. a story of pre-twisted flexible deck is introduced instead of setting dampers. A new concept comes from setting an appropriate configuration as stress-free state 0. The key idea is to redefine a stress-free configuration. As a consequence, the pre-twisted deck seems to show a improved behavior in dynamic analysis. At the same time, the strain and stress of the deck is decreased comparing with the original flexible deck.



Fig. 2. Concept of Pre-twisted flexible deck

5. Discussion and Conclusions

The research has proposed a novel concept for a movable footbridge supported by cables. Though there are several topics remaining to be solved, according to the information illustrated in this paper, investigation on the innovative concept of movable footbridge has highlighted new design possibilities for unique lightweight structures with curved configurations. Also, one solution for the dynamic performance was proposed with a pre-twisted flexible deck, showing a feasibility for the concept.

6. References

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