DMSUS, Shape-Finding Program for Irregular Suspension Bridge

Kyung Sik CHO
Vice President
DM Engineering Co., Ltd.
Seoul, Korea
drchoks@ dm-eng.com

Kyung Sik Cho, born 1962, received his Ph. D degree from Seoul National University in 1992. Currently he is the vice president of DM Engineering Co., Ltd.

Changsoo KIM
Director
DM Engineering Co., Ltd.
Seoul, Korea
brideng@dm-eng.com

Changsoo Kim, born 1970, received his B.S and M.S degree in civil engineering from Seoul National University. Currently he works for DM Engineering Co., Ltd.

Woo Jong KIM
President
DM Engineering Co., Ltd.
Seoul, Korea
wjkim@ dm-eng.com

Woo Jong Kim, born 1960, received his Ph. D degree from Seoul National University in 1990. Currently he is the president of DM Engineering Co., Ltd.

Summary

DMSUS, the 3-dimensional irregular suspension bridge analysis program, which can perform the shape-finding analysis and geometric nonlinear analysis, has been developed. In this program, TCUD (Target Configuration Under Dead loads) method which can overcome the drawbacks of the trial-and-error approach and the successive substitution method is adopted at cable-only system analysis and the initial force method which can control displacements of pylons and girders is adopted at total system analysis. Using this program, the designers can easily analyze the various types of suspension bridge like a single-pylon suspension bridge, an asymmetric-pylon suspension bridge, a multi-span suspension bridge and a suspension bridge including inclined pylons and hangers, etc. The accuracy and applicability of the developed program are demonstrated through numerical examples.

Keywords: DMSUS; Suspension bridge; Shape finding analysis; Initial equilibrium configuration; TCUD method; Initial force; Elastic catenary cable.

1. Introduction

In general, the initial length of members is defined from the geometric configuration before deformation since frame structures have stiffness even in the stress-free state. On the other hand, cable-supported structures such as suspension bridge can not be defined in the stress-free state since the stiffness of a cable is developed from applied tensions. So, it is necessary to define tensions or unstrained lengths of cables satisfying the given design conditions of suspension bridges and this analysis is referred to as the shape-finding analysis or the initial equilibrium configuration analysis.

With the recent advances of techniques to overcome the constraints of the terrain and the purpose of aesthetic design, the type of suspension bridge has deviated from typical form and become more various. These suspension bridges, however, are not easily solved with existing shape-finding analysis program and the designers are required to make more efforts.

On the other hand, DMSUS, which is developed from this research, performs the shape-finding analysis for suspension bridge based on only materials, sectional information and design criteria of suspension bridge regardless of the shape of the bridge. TCUD method and initial force method are applied as the shape-finding analysis method. The accuracy and applicability of the developed program are demonstrated through numerical examples.

2. Shape-finding analysis of suspension bridge

A suspension bridge is made up of main cables, hangers, pylons and girders and cable is used as main structure material different from other bridges. When determining the shape of the suspension bridge, the items that the designer can choose are longitudinal locations of hangers and pylons, vertical alignment of girders and sag of main span. Once these items have been determined, it is required to calculate the unstrained lengths and the longitudinal and transverse coordinates of cables that are connected to hangers through the shape-finding analysis.

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