Simulation of the construction process of cable-stayed bridges from a direct approach

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Summary

In order to complete the design of any structure, an adequate simulation of its construction process is required. This simulation tries to guarantee that the structure can be built safely, that is to say that safety thresholds are not exceeded during the construction stages. In the case of cable-stayed bridges, simulation procedures must be prepared to deal with the computational difficulties derived from their statically redundancy.

Traditionally, the simulation of the construction process of a cable-stayed bridge is carried out from two alternative simulation approaches: the Backward and the Forward approach. In these two methods structural changes produced during erection are successively added to the preceding (forward simulation) or the following (backward simulation) construction stage. This superposition of stages is the main trade off of these methods because it increases the computation time. Furthermore, these approaches do not enable the direct simulation of intermediate construction stages.

To solve these problems the Direct Algorithm (DA) is presented in this work to deal with the simulation of the construction process of cable-stayed bridges built on temporary supports. To speed up the computation, this algorithm takes advantage of the unstressed length of the stays concept. This assumption enables an innovative direct simulation of the construction process that does not require the superposition of stages. The DA is indicated for optimization processes and simulation of changes in the tensioning process of cable-stayed bridges. Furthermore, the DA is so simple that it can be implemented in any computer software.

Keywords: unstressed length, direct simulation, cable-stayed bridge, tensioning process.

1. Introduction

Wherever it is possible, short-medium span cable-stayed bridges are built on temporary supports [1]. In this erection method, the bridge superstructure is first erected on a set of temporary and permanent supports. Then, during the tensioning process, the load counterbalanced by the temporary supports is successively transmitted to the stay system. At the end of this tensioning process, a target geometry or stress state, known as the Objective Service Stage (OSS) [2], is achieved.

Many researchers and practitioners have stated the importance of properly simulating the construction process of cable-stayed bridges [3]. Traditionally this simulation is carried out backwards, that is, according to the opposite erection sequence followed on site. Several authors have proposed methods based on the backward approach for the cantilever [4, 5] and the temporary support erection method [6]. The main inconvenient of this simulation direction is the difficulty to model any modification in the bridge design and/or in its tensioning strategy as well as to model the effects of time-dependent phenomena. To overcome these problems, a forward simulation, which

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