# Erecting Analysis of Cable-Stayed Bridges by Substructure Procedures

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## Summary

The erecting analysis of cable-stayed bridges involves repeatedly modeling to sequential structural systems, in which substructure procedures is accomplished. A single tower cable-stayed bridge of rigid connection between girder, tower and pier is used as an example to illustrate the rules of substructure division and to perform the analysis of erecting stages. The erecting stages are simulated by 30 super-elements of successive mode. The calculating results show that the time consumption of substructure procedures is just one seventh of that by ordinary method with the comparative accuracy of both methods not exceeding 5%. Thereby, it is confirmed that substructure procedures are applicable to the erecting analysis of cable-stayed bridges with obvious advantages.

**Keywords**: cable-stayed bridges; substructures; super-elements; erecting analysis; construction simulation.

## 1. Introduction

For long-span cable-stayed bridges, the simulation analysis of erecting stages needs to model the sequential systems of bridge structures for many times [1]. The refined analysis of a large bridge will be difficult to perform due to the consumption of computing time, especially when based on the solid elements. Many investigations of construction analysis of long-span bridges have been restricted to the model of member systems [2] [3]. Only a few have dealt with the model of solid elements [4]. To meet the need of repeatedly analyzing sequential structures, the application of substructure procedures based on super-elements is suitable. The substructure technique is one of the important functions of large FEM programs, which reduces computing time and allows analyzing very large problems with limited computer resources. The structures containing repeated geometrical patterns are typical candidates for substructures to analyze [5] [6]. For a structure with repeated patterns, one super-element can be generated to represent the pattern and the copies of it can be simply made at different locations, thereby a significant amount of computing time can be saved. Every substructure, the modelling of which is independent, reduced its degrees of freedom by static condensation method; and the whole structure is solved by reassembling the matrixes of condensed substructures into whole structure matrix. This paper attempts to perform the analysis of erection process of cable-stayed bridges with segmental construction method by substructure procedures.

## 2. Fundamentals of substructure procedures

This section provides background material, which can be found in many texts [5]. Although the element analysis method of substructure procedures is as same as that of ordinary finite element

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