Chapter 24
A Computer-Aided Conceptual Cost Estimating System for Pre-Stressed Concrete Road Bridges

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ABSTRACT

The need for an environmentally friendly design of modern motorways increases the construction of bridges, which has exhibited substantial overruns above estimated costs. Therefore, easy to use, inexpensive and accurate methods for conceptual cost estimating are needed. This paper presents a computer-aided cost estimating system for pre-stressed concrete road bridges that provides estimates of the material quantities and cost of all bridge elements. It relies on a database incorporating actual data collected from recently constructed bridges and exploits material estimating models developed with statistical analysis. Different configurations are devised from short to long-span bridges, accounting for the major deck construction methods and foundation systems. The system can be easily used to provide different cost estimates to the owner, designer and contractor during the project's early stages. By allowing reliable cost estimates in a short time, the proposed computer-aided system represents a useful decision making tool.

INTRODUCTION

Preliminary cost estimates are prepared before the completion of the project's design and are based on the conceptual design of the project at the stage when only its basic technologies are known (Hendrickson, 1998). According to Wideman (1995), the conceptual phase is the first phase of a project, in which the need is examined, alternatives are assessed, the goals and objectives of the project are established and a sponsor is identified. Early cost estimates for engineering projects are extremely

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important to all the major parties involved in the construction process, such as the projects' owners, designers, contractors and sponsoring organizations. They are vital for business unit decisions involving determination of the project's feasibility and commercial viability, potential project screening through the comparison and financial evaluation of alternative projects, establishment of initial budgets and asset allocation. Even though conceptual cost estimates present the lowest expected accuracy, due to the limited available information, inaccurate cost estimates may lead to lost opportunities, wasted development effort and lower than expected returns (Oberlender & Trost, 2001) due mainly to the misjudging of technical and economical solutions.

Bridge construction has substantially increased over the last decade. The need to improve transport infrastructure in order to facilitate the mobility of persons and goods, improve the territorial cohesion of the European Union, thus increasing competitiveness and employment, has been identified as a major goal by the European Commission. In the same time, rising ecological awareness requires an environmentally friendly design for motorways that overcome difficult geological terrains and by-pass city centres and archaeological sites. Since bridge construction has traditionally exhibited substantial overruns above estimated costs (Skamris & Flyvbjerg, 1997; Odeck, 2004), easy to use, inexpensive and reasonably accurate methods for preliminary cost estimating are necessary.

This paper addresses the need for reliable cost estimates for concrete road bridges during the early stages of the project and presents a computer-aided cost estimating system that relies on information known before the detailed plans and specifications are identified. The system uses material estimating models developed with regression analysis on actual data collected from recently constructed bridges and provides estimates of the material quantities and cost of all bridge elements.

PREVIOUS RELEVANT COST STUDIES AND RESEARCH

Cost estimating systems for motorway bridges are very limited, due to the difficulty of acquiring actual cost and structural information for completed projects. Most research efforts address the lack of actual data with computer-intensive theoretical resolutions that optimize the final design through a trial and error process. They concentrate mostly on the bridge superstructure in order to eliminate site-dependent factors and optimize its design conforming to specific specifications and using standard shapes and cross sections. The algorithms produce material estimates that lead to cost estimates after applying the proper unit prices.

Several research studies address the optimization of pre-stressed concrete road bridges' superstructures. Lounis and Cohn (1993) identified three levels of optimization, i.e. the component, the configuration and the system. Even though the economic impact increases with higher levels, few research efforts address the optimization of the overall features of the bridge system.

Lounis and Cohn (1993) investigated several configurations of simply supported and continuous I-girder bridges with span lengths varying between 10m and 30m. They used the unit superstructure cost for a precast pre-stressed concrete bridge girder system as objective function and developed an optimization method for the design of the superstructure elements and standards for selecting optimal systems. Cohn and Lounis (1994) addressed superstructures consisting of solid or voided slabs, standard precast pre-stressed concrete girders and box girders. They developed a systematic procedure for the optimal superstructure design (longitudinal and transverse configurations and sizing of individual components), as well as graphs for the comparison of the superstructure cost. Aparicio et al. (1996) proposed a computer-aided design system for pre-stressed concrete highway bridges. The software starts from few