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Innovation in bridge life-cycle cost assessment

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Abstract

State administration authorities put pressure on effective management of public funds. The paper focuses on economical construction of civil engineering works - bridges. Bridges involve high investment costs, but, because of their estimated service life (100 years), significant operating costs are incurred associated with the maintenance and renovation of individual structural elements. The trend in tendering not only considers the investment cost amounts, but also takes into account the expected operating costs of completed structures. The Life Cycle Costing Methods for bridges are still under development and need further improvement so that the output data correspond to reality as much as possible. The paper summarizes the existing procedures and presents the latest innovations in modelling the life cycle costs of bridges built last year. These particularly relate to the cost basis update, but also revaluation of replacement cycles of individual structural elements, which is based on the latest technical knowledge resulting from real conditions of serviced bridges. The greatest innovation, however, is the computational model's linking onto two separate pricing databases. The calculation of maintenance costs is based on operational and expert data, broken into different bridge types. The replacement costs of individual structural elements are linked onto the database which is based on prices from designers. In this way, various technological demands for individual versions as suggested by designers are better captured, but, at the same time, maintenance costs, which are not subject to designers' pricing, will not be distorted. The paper presents a real tendering case which shows to what extent operating costs can affect the selection of the best version.

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Keywords: bridge, life cycle costs, maintenance, model, tender.

1. Introduction

The paper presents the methodology and tools for the assessment of the Life Cycle Cost (LCC) of bridges developed at the Czech Technical University in Prague (CTU in Prague). The fundamentals and practical usage of

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the methodology were applied as early as 2008 based on the Directive of the Managing Director of the Czech Road and Motorway Directorate No. 9/2008. The methods and outputs were published in [1,2]. In 2016, the pressure on design planning of bridge structures grew aiming at more effective management, and, consequently, the number of elaborated expert opinions on life cycle cost analysis of bridges also grew [3,4,5]. The state authority focusing on the review of procedures and methodologies used for effective fund management in transport infrastructure was the State Transport Infrastructure Fund.

In 2016, 61 bridge structures were methodically assessed at CTU in Prague, always minimally in two alternative versions, which was more than the assessments covering the whole period of 2008-2015. For these reasons, the emphasis was not only on the methodology update to fit current conditions, but also on the simplification of input forms for the assessment of bridges in terms of LCC, which are filled in by designers [6].

The paper presents the items which were modified and updated to make the LCC assessment process of bridges as precise, but also as effective as possible and to impose the least burden on the design agencies involved.

1.1. Model's principle

The model processes the estimated costs of maintenance and renewal at the level of individual structural elements [7,8]. Each design element has a defined pattern of these costs, considering technological linkages to other structural elements of the bridge. The result depends on the assessment of structural components and materials that are used [9,10,11]. The model returns the sum of discounted costs of renewal and maintenance for a specified period. This value is taken as the basis for the evaluation of the criteria. There will be a web application, Bridgepass, (http://www.cesti.cz/bridgepass/) - see Fig. 1, with which calculate the approximate value during the selection process.

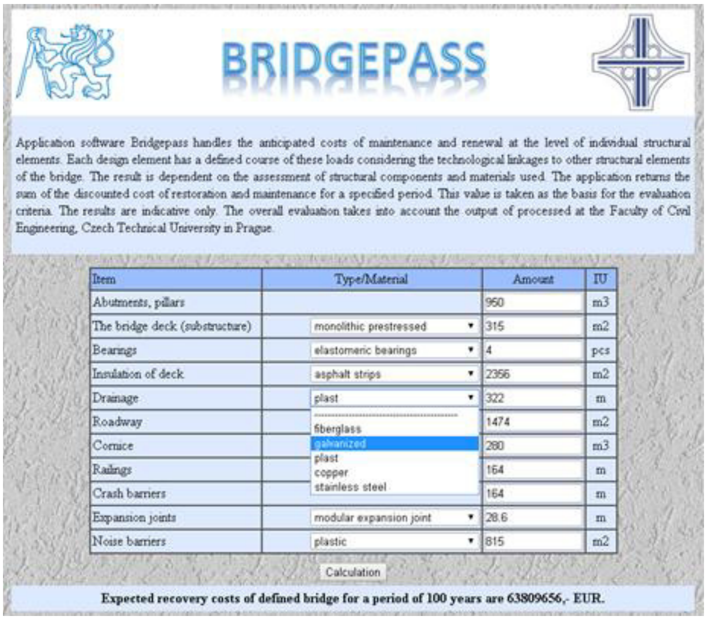

Fig. 1. Web interface of the Bridgepass application

The application calculates the costs of renewal and maintenance, which are generated from the following structural elements: abutments, pillars, bridge deck (substructure), bearings, insulation of the deck, drainage, roadway, cornice, railings, crash barriers, expansion joints and noise barriers. The structural elements can be entered in predefined type / material variations [12]. If there is a combination of materials used for one component, these materials are defined as separate structural elements.