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Comprehensive Approach to Efficient Planning of Formwork Utilization on the Construction Site

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Abstract

The paper presents a consistent approach to concrete works planning, which begins with formwork selection and ends with project scheduling. To work out the problem of formwork selection, selected MCDA methods are recommended. In order to apply them, the decisive criteria were recognized with a structured survey sent to contractors. The efficiency of formwork utilization is measured with a virtual cost of formwork under utilization, so when the formwork is available on the construction site but remains unused or when it should be struck but remains unremoved from the construction. Such measure was determined, after having analysed various criteria of schedule quality and optimality assessment.

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Keywords: formwork; monolithic concrete works; interactive planning; efficiency of formwork utilization

1. Introduction

Formwork is the largest single cost component of a concrete building's structural frame and varies averagely between 35 and 45% of a reinforced concrete structure's unit cost [1, 2]; for civil engineering structures it can reach even 60%. Formwork items are usually rented by the contractor to perform particular concrete woks. Therefore, considering their constructability and analyzing efficiency of their utilization at each stage of construction planning, in order to accelerate construction schedule or increase jobsite productivity, seems to be the smartest step to reduce lease costs and in consequence – total building works' costs.

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This brought about the idea to establish a new, consistent method of project planning which begins with formwork selection and ends with project scheduling, where formwork availability and utilization efficiency is being analyzed at once. The key issue to resolve the decisive and planning dilemmas settled in the research [2] was to identify problems and their constraints, that stem from specifics of the cast-in-place building technology. A thorough investigation on formwork selection problem, as well as project planning and scheduling methods was carried out. Its goal was to decide, whether it would be possible to adapt existing planning techniques to work out the solution for the subject matter. The whole planning method is explained in detail in [2], while the present paper describes a synthetic approach to the subject problem.

2. What influences on formwork utilization efficiency?

It can be easily stated, that having profound knowledge on monolithic concrete works' technology and formwork systems' features results in choosing an appropriate system to perform concrete works. This gives rise to: reduction of labor costs, improving the quality and safety of produced concrete, achieving faster work cycles [3]. Formwork selection is, thus, the first problem, that should be considered in order to improve formwork utilization on the construction site.

However, it is not the only one. The second issue is how to schedule works and plan formwork utilization effectively and how to measure such efficiency?

Effective formwork utilization should be understood as condition wherein formwork is being used to its fullest potential. During the building performance, the efficiency of formwork utilization should be measured with a cost of formwork under-utilization, so when the formwork is available on the construction site but remains unused or when it should be struck but remains unremoved from the construction. The rightness of such measure of schedule quality and optimality assessment was proved by Kapliński [4] and was incorporated into author's planning method in [2].

A combination of solutions to both problems introduced above should foster a growth in efficiency of formwork utilization on the construction site and enhance schedule quality. Such comprehensive approach to the described issue and consecutive steps of its solution are presented in Fig. 1 and are the subject matter of the present elaboration.

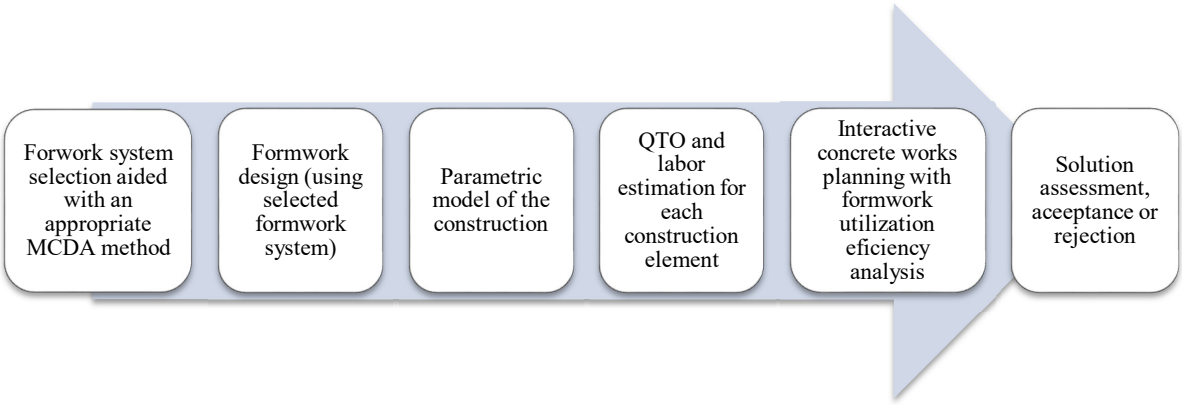

Fig. 1. A scheme of a comprehensive approach to formwork planning.

3. Formwork selection problem and its solution

3.1. Decisive criteria for the formwork selection problem

Factors that influence on formwork selection had been investigated since early 90's until now by various researchers in Poland, i.e. by Marcinkowski and Krawczyńska [5], Biruk and Jaśkowski [6] and all over the world, i.e. by: Hanna, Willenbrock and Sanvido [7], Kamarthi et al. [8], Proverbs, Holt and Olomolaiye [9], Elbeltagi et al. [10] or Shin et al. [11] and many others. The literature on the subject matter, both foreign and national, suggests