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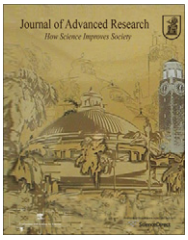

ORIGINAL ARTICLE

An optimization algorithm for simulation-based planning of low-income housing projects

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Abstract Construction of low-income housing projects is a replicated process and is associated with uncertainties that arise from the unavailability of resources. Government agencies and/or contractors have to select a construction system that meets low-income housing projects constraints including project conditions, technical, financial and time constraints. This research presents a framework, using computer simulation, which aids government authorities and contractors in the planning of low-income housing projects. The proposed framework estimates the time and cost required for the construction of low-income housing using pre-cast hollow core with hollow blocks bearing walls. Five main components constitute the proposed framework: a network builder module, a construction alternative selection module, a simulation module, an optimization module and a reporting module. An optimization module utilizing a genetic algorithm enables the defining of different options and ranges of parameters associated with low-income housing projects that influence the duration and total cost of the pre-cast hollow core with hollow blocks bearing walls method. A computer prototype, named *LIHouse_Sim*, was developed in MS Visual Basic 6.0 as

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proof of concept for the proposed framework. A numerical example is presented to demonstrate the use of the developed framework and to illustrate its essential features.

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Introduction

Significant advances have been made in the area of planning construction resources, leading to the development of a number of optimization models using a variety of approaches, including linear and integer programming [1], dynamic programming [2,3], genetic algorithms [4–8] and colony optimization [9]. While the above research studies have provided significant contributions to the area of optimizing construction resources utilization, there has been little or no reported research focusing on developing advanced multi-objective optimization models that are capable of modeling the construction process of low-income housing, considering the associated uncertainties and optimizing the different conflicted objectives. The uncertainties associated with construction projects are attributable to several factors including unexpected soil conditions, equipment breakdown, unexpected weather variability and large numbers of changes. Such uncertainties can be captured in representations of the duration of activities [10].

Computer simulation is a powerful tool that can be used for analyzing new systems. A simulation project uses a model that considers the associated uncertainties in order to investigate their potential impact on project objectives. Analysis of projects using simulation is performed for several purposes. These include: evaluation of a proposed system; comparison between alternative proposals; prediction of system performance under different conditions; sensitivity analysis to determine the most significant factors affecting the performance of a system; establishment of functional relations to identify any relationship among the system significant factors; and bottlenecks analysis to identify the factors that cause system delays. Computer simulation is one of the techniques that has been used to model uncertainties involved in construction operations. Typically, modeling utilizing simulation can be applied either in a general or in a special purpose simulation environment. General purpose simulation (GPS) is based on formulating a simulation model for the system under investigation, running the simulation and analyzing the results to decide whether the system is acceptable or not. If the case is unacceptable, the process is reiterated and a new alternative system is considered. Various

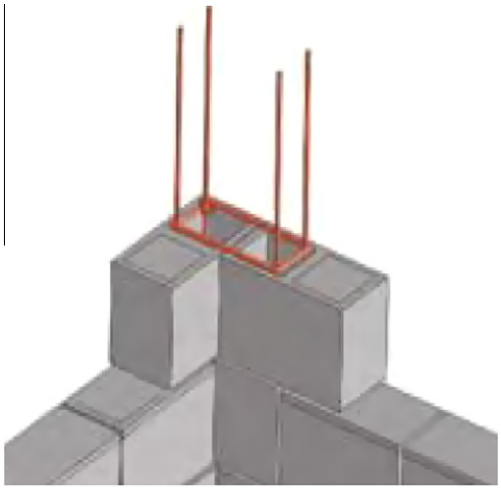

Fig. 2 Block walls additional reinforcements.

Fig. 3 Installing hollow core strip slabs.

Fig. 1 Pre-stressed hollow core strip slab.

Fig. 4 Topping above hollow cores strips.

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