Comparative Analysis of Bridges Construction Methods Using Bridge Information Modeling

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ABSTRACT

Bridge information modeling (BrIM) has widely become an efficient tool in the bridge engineering and construction industry. It has been used in pre-fabrication, obtaining accurate quantity surveys, and creating accurate shop drawings. This article presents the utilization of bridge information modeling (BrIM) in determining the optimum construction methods of concrete bridges in Egypt using systematic procedures taking into account: bridge physical properties, construction cost, and site conditions. Bridge information modeling (BrIM) has proven to be an effective tool in determining the optimum construction methods of concrete bridges. The proposed BrIM approach is capable of obtaining feasible construction methods and associated construction costs based on bridge physical characteristics.

KEYWORDS

Bridge Information Modeling (BrIM), Concrete Bridges, Construction Management, Construction Methods

INTRODUCTION

In Egypt, bridges play a vital role because of the presence of The River Nile which divides Egypt into three main areas which are: Delta, the Eastern area, and the Western area. Bridges provide the required connection between these three areas and help to overcome traffic problems. Concrete bridges are the most common type of bridges in Egypt. Choosing the construction method of concrete bridges is an important task in bridge projects as the bridge construction method has significant effect on bridge design, and construction cost and duration. This task is always based on experts’ knowledge and experience without systematic procedures. It is important to have an integrated decision support system to select the optimum construction methods of concrete bridges in Egypt considering the bridge physical characteristics, the site conditions, and the available budget for construction.

CONSTRUCTION METHODS OF CONCRETE BRIDGES IN EGYPT

Basha and Gab-Allah (1991) stated that the construction methods that are mainly utilized in Egypt include: erecting precast concrete girders using launching girders, cast-in-place (CIP) free cantilever, incremental launching, precast segmental on falsework, precast segmental free cantilever, and cast-in-place (CIP) reinforced or prestressed concrete on falsework. Youssef, Anumba, and Thorpe (2005) summarized construction methods used in Egypt as follows: stationary formwork (SF) either directly

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supported on the ground with full occupancy of the ground or by creating an elevated platform (EP) with no or limited occupancy of the ground; advancing shoring system; erecting beams using; heavy lifting, cranes, or launching trusses (LT); horizontal incremental launching; cast in-situ free cantilever (FC) construction using two travelers; and cast in-situ free cantilever (FC) construction using one traveler and stationary formwork on the other side. Detail description of these methods can be found elsewhere (Youssef, 2006; Marzouk, Zein El-Dein, & El-Said, 2007). Youssef (2006) developed a decision support system that provides a systematic and structured framework to improve the process of selecting the construction methods of bridges’ superstructure in Egypt.

IMPLEMENTING VISUALIZATION IN CONSTRUCTION

Visualization is considered an effective feature in construction projects. It simulates the construction process in 3D environment in order to be provide better understanding of project components, sequence, work flow, and equipment utilization; it supports and facilitates effective decision making. Visualization has been utilized in several construction applications. Rohani (2013) presented advanced visualization techniques for modern construction management. Castronovo, Lee, Nikolic, and Messner (2014) provided a set of visualization guidelines for representing the construction process. Lin, Zhang, He, and Hu (2015) presented automatic verification and visualization of a schedule driven 4D model in order to reduce rework and mistakes. Zhou and Wang (2009) applied 4D visualization in bridge construction management and control. Kamat and Martinez (2001) presented a system that supports visualizing the resulting products and the construction operations in a 3D environment. Kang, Chi, and Miranda (2009) presented a system that provides a detailed planning and visualization in a virtual construction environment which can be used to assist crane operators in real-time during erection. Kamat and Martinez (2005) presented an approach that allows 3D visualization and animation of construction equipment in construction operations. Chau, Anson, and Zhang (2004) provided a 4D model for visualizing daily activities for more effective planning and controlling. Kamat and Martinez (2005) utilized visualization for identifying conflicts that could happen among dynamic, static, and abstract construction resources in 3D animations of discrete event simulation models. Behzadan and Kamat (2010) presented augmented reality (AR) that utilizes graphical visualization to plan and design construction operations by creating and translating realistic visual outputs into 3D virtual contents (CAD model engineering) of the animated scenes.

BUILDING INFORMATION MODELING (BIM)

Building Information Modeling (BIM) is concerned with developing and utilizing a computer software model to provide an effective simulation for construction and operations of a specific facility (AGC, 2006). A Building Information Model (BIM) is a digital representation which is characterized by sharing and supporting open standards for compatibility and interoperability (NIBS, 2007). The resulting model, a Building Information Model is used to extract and analyse data in order to generate information that facilitates effective decision-making and improve the process of facility delivery (Marzouk et al., 2014).

The major objective of BIM is developing an integrated model that can be utilized throughout the project’s life cycle (Fernández-Solís & Mutis, 2011). BIM has several advantages throughout the project’s life cycle which are (ASHRAE, 2010): parametric modelling, time saving, cost reduction, automating fabrication, enhancing estimation of costs and procurement management, and facilitating complex construction.

The 4D modeling is done by linking the scheduling data with the 3D model, while the 5D modeling is done by quantifying data and applying cost information by using the 3D model (McCuen, 2008). The 3D bridge model can be used for several purposes including generation of shop drawings,
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