# BUILDING INFORMATION MODELING: FROM CONTRACTOR'S PERSPECTIVE

By

BY ASIT BAXI

POST-TENSIONING INSTITUTE ®

Authorized reprint from: December 2016 issue of the PTI *JOURNAL*

# BUILDING INFORMATION MODELING: FROM CONTRACTOR'S PERSPECTIVE

**BY ASIT BAXI**

## INTRODUCTION

Building Information Modeling (BIM) is a very powerful technology that is increasingly becoming mainstream in every facet of building design and construction in the United States and around the world. As companies begin to see the value of BIM, more and more companies will be investing in this technology and will not want to be left behind.

BIM has a come a long way from the original idea of depicting a building in three-dimensional space for easy visualization to the development of extremely detailed three-dimensional models of entire structures and complexes. It captures the physical and functional aspects of the structure starting from project inception, design development, construction, future modification and long-term maintenance. Combined with advances in computing technology and available storage, either physical or in the cloud, constant refinement and addition of different components to BIM, this technology is continuously evolving.

The various stakeholders in BIM are usually the owners, architects, engineers, specialty consultants, contractors, sub-contractors, testing and inspection agencies, suppliers, manufacturers, etc. This paper provides an overview of what BIM is and how it can be used by contractors and subcontractors for post-tensioned structures.

## BIM AS IT CURRENTLY STANDS IN THE INDUSTRY

As reported by "Dodge Data Analysis Smart Market Report 2015" the percentage of projects in the US that use BIM technology at some level has increased from 28% to 71% from 2007 to 2012. Currently, the stakeholders that use BIM in a significant number of projects are architects, engineers and specialty consultants for the MEP trades. There are a handful of contractors that implement BIM for the entire project from project inception to complete construction. The contractors that do utilize BIM, use it to a limited extent for clash detection for MEP trades, embedded items & structural components, laser scanning for field verification, checking construction tolerance, fixing errors during construction etc. Use of BIM by post-tensioning subcontractors is very limited at this time. Post-tensioning detailing in BIM is used in very limited instances for example where reinforcing congestion is an issue such as in transfer girders or complex beam-column joints or in cases where there is potential interference between embedded items and post-tensioning tendons or anchorages.

## HOW ARE CONTRACTORS USING BIM IN THE UNITED STATES

The degree and extent to which BIM is used by the various stakeholders is best described and specified in the AIA - American Institute of Architects BIM standards (AIA E202™). The expectations for levels of modeling precision are defined by Level of Development (LOD) of the elements to be included within the model. The model levels start from LOD 100 (conceptual models), LOD 200 (generic placeholders), LOD 300 (specific, object or assembly), LOD 350 (LOD 300 plus support and connections), LOD 400 (specific system, object or assembly along with detailing, fabrication, assembly, and installation information) to LOD 500 (as-built).

Currently, there are just a handful of general contractors in the US (early adopters of BIM) who use this technology from project inception to construction. These early adopting companies having put forth significant efforts have been very successful in creating their own add-ins to popular software platforms which has allowed them to use BIM models in the LOD 300 to LOD 400 range. There is partial delivery of the BIM model at the LOD 500 level. These contractors are utilizing BIM models for estimating/quantity takeoffs, scheduling, preparation of installation drawings, coordination drawings, fit up testing, conflict resolution, overall project quality control and finally using laser scan technology for preparation of as-built models.

Majority of the contractors in the country that use BIM are at the LOD 200 to LOD 350 levels. Use of BIM for the post-tensioning elements at this time is in its infancy with its use in very limited number of projects. For the cases where it has been used, the models that have been developed are at the LOD 300/350 level. Use of BIM at the LOD 400 level: which is for post-tensioning and rebar detailing, fabrication, assembly, and installation is yet to be fully developed and is not commercially available.

Development of software and the investment required by the various stakeholders to obtain fully functioning LOD 400 models for post-tensioned buildings will require concerted efforts between the software developers, contractors, engineers, code entities (such as PTI and ACI) and above and all the most important players: the post-tensioning suppliers. There are current efforts to develop software that can model the different post-tensioning elements for unbonded and bonded tendons such as in Figure 1. It is expected that in the near future, software will be available that can model unbonded and bonded tendons with their respective anchorages; tendon material properties: strand properties-modulus of elasticity, strand cross-sectional area, sheathing information, PT coating information; tendon loss parameters: initial losses based on friction coefficients and seating loss for a specific tendon type and long term losses.

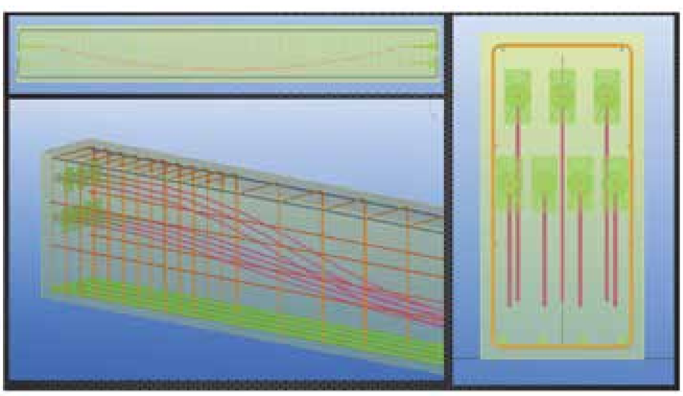

*Fig. 1—BIM model of a unbonded post-tensioned beam (Photo Courtesy of Ashton BIM Creation)*

*Fig. 2—Extracted digital image of a post-tensioned slab from a laser scan. (Photo courtesy of Hensel Phelps Construction)*

There are several reasons why the post-tensioning industry has lagged behind in embracing BIM technology in the author's opinion. It took a long time for the architectural and engineering community to transition from ACAD to REVIT and other 3-D modeling platforms. There is a significant level of investment required in moving to the BIM platform and the returns usually take a long time. The other and quite significant reason from the PT suppliers' perspective is that the post-tensioning system, which for many years was considered a "magic box" and a highly engineered product, has started becoming more and more of a commodity. With the transition to BIM there will be a further movement in this direction. There is a general concern that the general contractors will not utilize the specialty knowledge that the PT suppliers can offer and will further push post-tensioning materials towards being a commodity, rather than treating it as an engineered product.

## ADVANTAGES OF USING BIM FOR CONTRACTORS

Projects that use BIM technology to its fullest will most likely result in projects with a higher construction quality, much less conflict during both design and construction and faster project delivery resulting in overall savings. Potential conflicts can be identified in the early stages and mitigated in a virtual environment.

BIM has tremendous benefits for the contractor: starting from bidding, pre-construction, during construction, and in preparing as-built models for the owner after construction has been completed for future maintenance and any future modifications.

Contractors can use BIM to prepare accurate bids with a higher degree of precision compared to traditional estimating methods. Allowances for waste and material quantity uncertainties can be reduced resulting in much more competitive bids.

Before construction begins, BIM allows the contractor to streamline construction operations: better coordination and scheduling, control and planning resulting in increased productivity and efficiencies; mitigating and addressing conflicts during construction and better construction

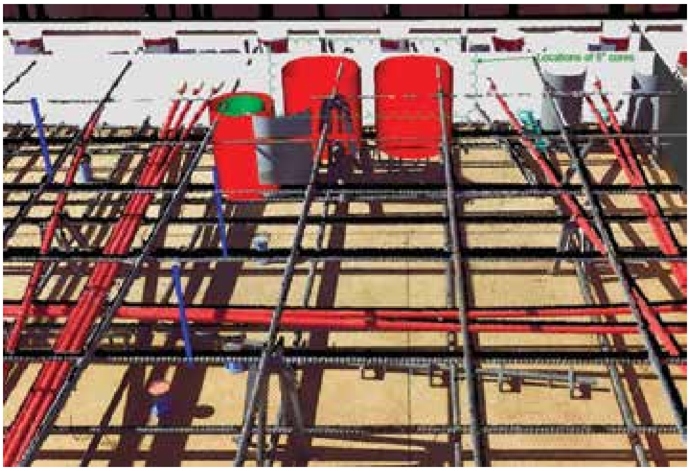

*Fig. 3—Laser scan of poured slab showing PT tendons and reinforcement. Contractor wanted to add 2 openings that were missed during construction – coring locations shown in red.*

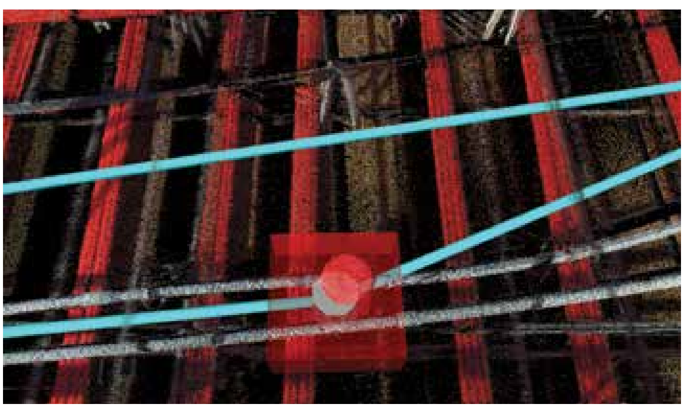

*Fig. 4—Laser scan of poured slab showing PT tendons and reinforcement. Contractor wanted to repair broken embedded electrical conduit by coring a small partial depth hole through the existing slab.*

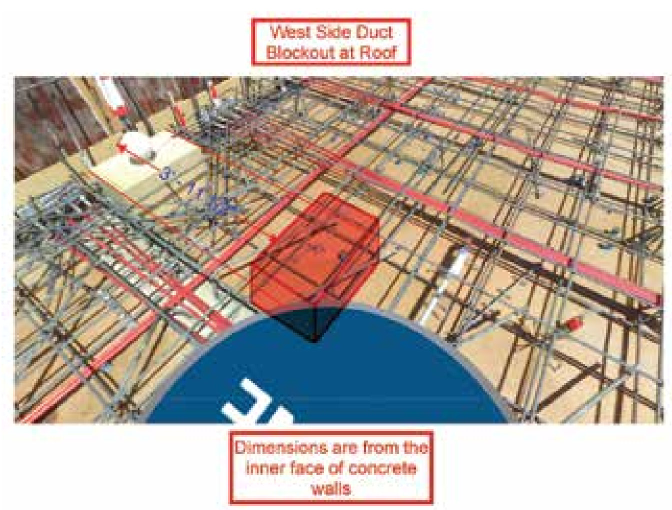


*Fig. 5—Laser scan of poured slab showing PT tendons and reinforcement. Contractor wanted to relocate block-out from its original location to accommodate modifications. New location marked in red.*

sequencing. BIM allows better communication and coordination between the various stakeholders - owners, architects, engineers and other trades resulting in fewer change orders, rework, fewer RFI's and hence overall reduced project costs.

During construction, laser scans can be used to make a digital representation of the as-built condition of the various structural elements. Figure 2 shows extracted pictures from a digital laser scan of a post-tensioned slab. The use of laser scan techniques is a very powerful tool that can be used during various stages of construction. It is very useful to check construction tolerances, equipment clearances in the as-built condition, to fix errors during construction (Fig. 3), perform repairs (Fig. 4), make additions & modifications (Fig. 5) during and after construction. It is a great tool to perform design validation. Laser scans have the capability to record spatial data to the nearest 1/16th of an inch and even closer accuracy. There is software available to convert the scans into an as-built BIM model for future use.

## WHAT IS THE FUTURE?

As it currently stands, contractors' use of BIM to deliver projects with or without post-tensioning at the LOD 400 level and higher is still in its infancy. Like adopting any new major technology, change is always hard, especially when one is used to doing something a certain way for decades. The post-tensioning industry and its key players namely the PT suppliers need to re-calibrate their business models and reinvent themselves to remain relevant players in the future market place.

**Asit N Baxi**, *PhD, President, Baxi Engineering Inc. He has over 25 years' experience as a structural engineer in the area of prestressed concrete; he is recognized as an industry expert on post-tensioned buildings. He owns and runs a full-service post-tensioned concrete specialty engineering firm with specialization in the analysis and design, construction, repair, and forensics of different types of post-tensioned concrete structures utilizing any type of post-tensioning systems.*

*He is a member of PTI Committees DC-20, Building Design; DC-110, Building Information Modeling; and TAB-120, Technical Advisory Board; ACI Subcommittees 301-I, Post-Tensioned Concrete, and 318-G, Precast and Prestressed Concrete; and Joint ACI-ASCE Committee 423, Prestressed Concrete.*