U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM

TOPIC Brief

Building Information Modeling and Demonstrating Code Compliance

Demonstrating or verifying compliance with codes, standards, or other criteria governing building design is achieved through a set of specific tasks. These include producing construction documents; providing specifications for the products, materials, equipment, and systems to be used; and describing how they come together to create the envisioned building.

When building construction documents and specifications are produced, they should include all information necessary to prescribe how the building is to be constructed. Plans and specifications should be readily usable to verify compliance with prescriptive requirements of codes, standards, or other desired criteria. Where codes, standards, and other criteria tend to be performance-based, additional steps are necessary to document that the building as designed will perform as required. If the criteria are outcome-based, compliance can be assessed after construction (e.g., duct leakage testing, actual building energy consumption).

This process—the series of tasks required to demonstrate or verify compliance—is not likely to change. What is changing is the way it can be accomplished given the availability of new information technology (IT) and software tools. Consider plans, specifications, and construction details in a traditional sense, whether on paper or some electronic media that simply facilitates transmission of

the information. Consider, then, the codes, standards, and other criteria that must be satisfied. To document compliance, all relevant information must be captured in the plans and specifications. To check for compliance, the codes, standards, and other criteria must be on hand, and then the plans and specifications compared against those requirements. This is traditionally done "long hand," although IT and software can help.

What if every detail of the codes, standards, and other criteria was stored in a database, and in seconds the building could be visualized as built in accordance with the plans, specifications, and any non-compliant items listed? This is possible with IT and software available now.

Building Energy Codes

Building information (BI) has been captured on paper for decades and more recently in electronic versions. The availability of software makes it possible to load BI into a program that then generates a BI model (BIM). Who hasn't considered a kitchen remodel or some other home improvement program without being able to visualize it through software? While very little data are necessary to visualize a kitchen remodel (e.g., color, texture, style, dimensions), that BI file of kitchen design inputs represents a BIM. Now expand this concept to an entire building. All the information relevant to documenting or verifying code compliance can be placed in the BIM. With respect to energy codes, BIM inputs can include:

- Dimensions
- Material properties
- Locations of systems
- How the envelope is assembled
- What is conditioned or non-conditioned
- Lighting wattage
- Space names
- Any other item related to energy codes, standards and other criteria to be satisfied.

Once incorporated in the BIM, the data are in an electronic format that allows them to be easily "read" and applied to create 2-D, 3-D, and 4-D (time) views of the entire building or any portion of the building. The BIM is then available for "use" by other software to perform certain tasks. For example, energy modeling and analysis tools can work within the BIM environment using available BI to generate design specific results. Using a highly detailed and accurate BIM of a facility also allows designed performance to be validated upon commissioning and then monitored over the life cycle of the facility to ensure it performs the way it was designed throughout its life. In addition, feedback to the BIM-based energy analysis tools allows constant improvement to ensure predictive performance is in fact a true measure of the actual performance.

The type, quantity, and quality of data in the BIM determine its ability to perform specific tasks. Cost estimating and scheduling are some simple examples. Another is clash detection, when software can identify instances where more than one object (e.g., wire, duct, structural column, pipe, doorway) is designed to share the same space. It is certainly much easier, less costly, and less time consuming to identify these instances before construction. Consider compliance verification as a form of clash detection. Codes, standards, and other criteria can be formatted in a way that software can recognize and apply as a rule set in clash detection. The BIM then represents the building, against which the codes and standards rule set is compared. Where the BIM "clashes" with the rule set, an item of non-compliance is identified. Clashes can then be dealt with prior to construction, which results in fewer non-compliant issues seen by the code official in the field.

Work on code compliance checking and verification was conducted by the International Code Council (ICC) from 2005 to 2009 as the SMARTCodes project. Rule sets for the energy code and accessibility and egress provisions of the building code were developed and documented. Although work on the SMARTCodes project at ICC has not continued, others such as Fiatech and BIM software developers continue to explore automated code checking through BIM. It is envisioned that as this application for BI modeling—along with others such as cost estimating, scheduling, and even virtual construction—advances, it will increase in use and yield reductions in costs and timeframes associated with building design and construction.

The work of organizations supporting the development of open BIM standards through the buildingSMART alliance will ensure that all users of BI, including code officials, can access and use such information to perform their duties.

Further resources on BIM include:

- The BuildingSMART Alliance www.buildingsmartalliance.org
- The Business Value of BIM: Getting to the Bottom Line, McGraw Hill Construction www.bim.construction.com/research/
- www.fiatech.org

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