



BIM LEVEL OF DEVELOPMENT FOR CIP CONCRETE—TECHNOTE

Keywords: beams; building information modeling; cast-in-place; columns; level of development; slabs.

Introduction

Building information modeling (BIM) presents structural information in the form of three-dimensional (3-D) graphical representations of elements such as beams, columns, and slabs. This information may be further associated with metadata (nongraphical information) such as compressive strength, reinforcement ratio, and maximum aggregate size. It is not necessarily possible to review a modeled object and understand its accuracy or intention. Viewers of models tend to assume designs are more complete than they may actually be, partially due to highly detailed graphics. Does this object represent 10, 30, or 80% of the final design?

The American Institute of Architects (AIA) created a level of development (LOD) classification system ([AIA E202-2009](#); [AIA G202-2013](#)) to help resolve this problem and to provide clarity in contracts. The industry has embraced AIA's LOD approach, and [BIM Forum \(2020\)](#) has defined five LOD levels (100, 200, 300, 350, and 400) in its “Level of Development (LOD) Specification” that are widely recognized and in use. A standardized LOD schema allows a structural object to be tagged with a numerical value that communicates its progress along the design development process, from concept to fabrication and construction. These LOD values can be assigned to individual items in released models to communicate intent clearly.

The LOD levels are defined in BIM Forum's “Level of Development (LOD) Specification” as follows:

LOD 100: No project-specific geometric representation—symbolic representation only. Element information is approximate. *Concept Stage*

LOD 200: Geometric representation is based on generic prototypes. Element information is approximate. *Preliminary Design*

LOD 300: Quantity, size, shape, location, and orientation of elements is modeled. Some nongraphical information attached to object. *Design Development*

LOD 350: Parts necessary for coordination of elements with attached element are modeled. These parts facilitate detailing and construction planning. Nongraphical information attached to objects is further developed. *Ready for Detailing and Concrete Mixture Design*

LOD 400: The modeled object is sufficiently accurate for fabrication and construction. Nongraphical information is complete. *Ready for Construction*

BIM Forum's specification covers a wide variety of project components, from substructures to landscaping. Multiple components are often grouped together within this specification using OmniClass designations. While BIM Forum's document is the best industry guidance available, grouping of concrete objects using OmniClass designations such as “substructure” when defining LOD levels for unsimilar individual objects such as reinforcing bars, concrete members, formwork, and embedments can be inefficient and limiting.

Question

For building information models (BIM) at different levels of development (LOD), what information is recommended for cast-in-place (CIP) concrete structures?

Answer

This TechNote defines, in general terms, the information required in a CIP BIM at various LODs (100, 200, 300, 350, and 400). These definitions apply to individual concrete objects such as beams, columns, and slabs. Within these structural objects, LODs for subcomponents including concrete, reinforcing bars, specialty reinforcement, prestressing, specialty systems, embedments, and formwork are defined.

Note that in any given structural model, not all elements are expected to be included, and for those elements that are included, not all are expected to be at the same LOD. For example, column line beams may have subcomponents at LOD 350, whereas secondary beams are at LOD 300. Additionally, not all components of a concrete object may be at the same LOD. For example, the concrete model of a beam may be at LOD 300 (that is, all geometric information complete and compressive strength defined), while the reinforcing bars for the beam may be at LOD 200 (that is, approximate reinforcement ratio only), and prestressing information may not be included at all.

LOD 100	
Concrete	Concrete columns, beams, slabs, and walls are represented in approximate locations. Other concrete members may be represented. Member thicknesses and cross sections, if provided, are approximate.
Reinforcing bar	None
Specialty reinforcements	None
Prestressing	None
Specialty systems	None
Embedments	None
Formwork	None

LOD 200	
Concrete	Concrete columns, beams, slabs, walls, and foundation elements are represented in approximate locations. Member thicknesses and cross sections are approximate. Major openings in concrete elements are represented in approximate locations.
Reinforcing bar	Typical reinforcement (such as “No. 5 at 12 in. EW EF”) or approximate quantities per unit area or volume are represented as nongraphical information associated with the reinforced element.
Specialty reinforcements	None
Prestressing	Prestressing systems are represented as nongraphical information associated with the prestressed element. Approximate quantities of prestressing steel per unit area or volume may be provided.
Specialty systems	Significant specialty systems (voided slabs system, specialty reinforcements) are represented as nongraphical information associated with the related elements.
Embedments	None
Formwork	None

LOD 300	
Concrete	Concrete columns, beams, slabs, walls, foundations, and other structurally significant concrete elements are represented at specified locations with specified thicknesses and cross sections. All structurally significant openings and insets are represented at specified locations. Maximum spacing for expansion/contraction joints may be specified. Architectural insets (chamfers, reveals) and additions that are not structurally significant may be represented. The following concrete mixture information is provided through nongraphical information associated with the concrete elements: a) Strength b) Nonstandard weight characteristics (lightweight or heavyweight) c) Special durability requirement, such as sulfate-resistant cements d) Maximum water-cementitious materials ratio (w/cm)
Reinforcing bar	Primary reinforcement is represented either graphically and/or as nongraphical information associated with the reinforced elements. Reinforcement representations include: a) Size b) Grade c) Spacing d) Nominal location within reinforced element (such as top, side, inside face) The following reinforcement information may be missing or approximate: a) Reinforcement connecting concrete elements, such as corner bars and dowels b) Reinforcement at openings, edges, and embedments c) Reinforcement intended only to support tendons or other reinforcement d) Reinforcement splicing locations and details e) Reinforcement cutoff locations and details, such as hooks and terminators If represented graphically, reinforcement is positioned accurately within cross sections of linear elements such as columns and beams and is positioned accurately within the through-thickness of surface elements such as slabs and walls. Textual nominal locations (top, side, inside face) may be provided for graphically represented reinforcement.
Specialty reinforcements	Specialty reinforcements are represented graphically and/or as nongraphical information associated with the reinforced elements. Sufficient information is provided to identify and position the reinforcement.