InSights

new trends, new techniques and current industry issues

The image shows a structural steel bracing member at three LOD levels. The LOD 300 brace is for permit level structural documents. LOD 350 brace with gusset plates is for trade coordination and LOD 400 brace with welds is for shop drawings.

Level of Development in BIM

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No technology has applied as great of an external force of change to the structural engineering profession as Building Information Modeling (BIM). BIM is requiring firm owners to be flexible as project scopes, and possibly their standard of care, evolve. The trend for building owners requests for the design teams to share their 3D models with contractors continue to increase. Additionally, building officials are beginning to look at structural models as the deliverable for automated code checking. The need for tighter scope definition highlights the importance of establishing the Level of Development (LOD) of BIM structural elements. All structural engineering firm owners in 2012 must take an active role in understanding the changes BIM enables in the building industry, and how to properly define the scope of their base services as well as additional services.

This article addresses the background of the LOD concept, discusses the author's newly proposed LOD 350, and discusses current trends in LOD. Most importantly, no two sets of firms, projects, contract forms, or clients are the same. There are many different opinions on the topic of who should model what and to what LOD. Some firms seek to limit the LOD they model in an effort to manage risk within traditional fee structures. Others seek to expand their scope for additional fees and possible risk. The importance of LOD is that it allows all of these firms to clearly define the scope they choose.

The AIA E202 document contains a table for defining the "Level of Development" of the BIM (AIA E202 § 1.2.3 Model Element) on a scale of 100 to 500. LOD in AIA E202 describes the level of completeness to which a model element is developed. It is important to emphasize that LOD only applies to individual model elements and not an entire model. For example, there is no such thing as an LOD 300 model when defining scope. Additionally, a model element author is defined as the party responsible for developing the content of a specific model element to the LOD required for a particular phase of a Project.

Definition of the intended use of the model elements is also possible in E202, which addresses use cases. Currently, the dominant use case for structural engineers is the creation of 2D documents. Other structural use cases are estimating, 3D spatial validation (clash detection), automated (CNC) fabrication, and many others, such as automated structural code checking in building departments.

Model elements at LOD 100 may be graphically represented with a symbol, but they do not have any indication of actual physical geometry. For structures, there is seldom any content modeled at LOD 100. Information related to the model elements (i.e., cost per square foot, steel or reinforcing pounds per square foot, etc.) is often derived from a textual structural narrative that the engineer provides to accompany the architects early mass model of the building. At LOD 200, an element is graphically represented as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. From this point the model elements progress to LOD 300 where it is graphically represented as a specific system, object or assembly which is accurate in terms of quantity, size, shape, location, and orientation. For full trade coordination, however, additional element development is often needed beyond LOD 300. For this reason, the author has advocated on the joint BIM Forum (AIA working group on LOD) for a newly proposed LOD 350, "Assemblies for Coordination". LOD 350 is defined as the Model Element being graphically represented within the Model with the detail necessary for cross-trade coordination and construction layout. Beyond 350 is LOD 400, "Detailed Assemblies."

At LOD 400 the model element is graphically represented as a specific system, object or

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assembly that is accurate in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. While LOD 500 is beyond the scope of this discussion, it is the model element level where As-Built and facility management information is integrated into the model elements. Non-graphic information may also be attached to the model element at any LOD.

The *Figure* shows an example of LOD with a main structural steel brace member at three different LOD levels. At LOD 300, the brace is sufficiently developed to create permit construction documents with plan and framing elevation images. However, for cross trade coordination with MEP systems, for example, the construction team needs the member's gusset plates modeled which correlate to a brace at LOD 350. After trade coordination, the brace element would be developed further to LOD 400 for fabrication level modeling. This level includes all the connection information of the brace needed for shop drawing creation and computer numeric controlled (CNC) automated fabrication and welding.

In structural design models, main structural members and systems are normally modeled with standard modeling tools for the creation of 2D construction documents. Higher levels of structural element information are usually proscribed with typical details. Examples of these structural elements are gridlines, levels, columns, beams, slabs, walls, main gravity systems and main lateral systems. Construction drawings made from the LOD 300 model are accompanied by additional 2D information such as general notes, typical details, specific details and specifications to define higher level information not typically shown in ⅛-inch scale plans or modeled for permit drawings.

Most main structural member elements are at LOD 300. However, structural engineers must be mindful that LOD 300 requires elements to be in the correct location. Thus, sloping roof members that are modeled flat are not at LOD 300, even though the 2D plans made from them appear correct. Other areas of misunderstanding are structural elements shared with architecture such as tilt walls, slabs and load bearing masonry walls. The structural engineer's scope should address who is responsible for modeling items such as floor depressions, openings, top of wall heights of parapets, etc.

Future trends to look for are new use cases for models that include automated structural code checking. Such trends may require structural engineers to expand their traditional scope to include modeling elements to a higher LOD during design, including gravity and lateral loading along with classifications for special inspection requirements for each member.

Regardless of one's personal opinions of how the structural profession should use BIM, few fail to see that BIM use is expanding in structures far beyond just a tool for creating 2D documents. The significance of the LOD concept is that it is an important tool to help define the structural engineer's scope in BIM. For additional information on this topic, visit **www.SEIBIM.org** for resources on the topic or send an email to **structures@IKERD.com**.▪