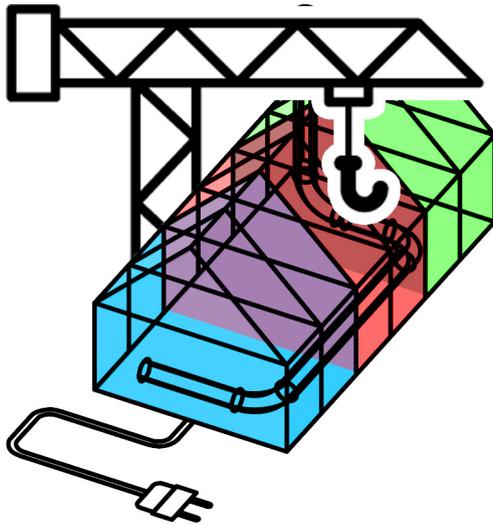


COBIM

Common BIM Requirements
2012

v 1.0



Series 13

Use of models in construction

Foreword

The publication series “Common BIM Requirements 2012” is the result of a broad-based development project entitled COBIM. The need for these requirements arises from the rapidly growing use of building information modeling in the construction industry. During all phases of a construction project, the parties to the project have a need to define more precisely than before what is being modeled and how the modeling is done. “Common BIM Requirements 2012” is based on the previous instructions of the owner organizations and the user experiences derived from them, along with the thorough experience the writers of the instructions possess on model-based operations.

The parties to the project are: **Funding providers:** Aitta Oy, Larkas & Laine Architects Ltd, buildingSMART Finland, City of Espoo Technical and Environment Services, Future CAD Oy, City of Helsinki Housing Production Office, City of Helsinki Premises Centre, University of Helsinki, Helsingin Yliopistokiinteistöt Oy, HUS Kiinteistöt Oy, HUS Premises Centre, ISS Palvelut Oy, City of Kuopio Premises Centre, Lemminkäinen Talo Oy, Micro Aided Design Ltd. (M.A.D.), NCC companies, Sebicon Oy, Senate Properties, Skanska Oy, SRV Group Plc, Sweco PM Oy, City of Tampere, City of Vantaa Premises Centre, Ministry of the Environment. **Written by:** Finnmap Consulting Oy, Gravicon Oy, Olof Granlund Oy, Lemminkäinen Talo Oy, NCC companies, Pöyry CM Oy, Skanska Oyj/VTT Technical Research Centre of Finland, Solibri, Inc., SRV Rakennus Oy, Tietoa Finland Oy. **Management:** The Building Information Foundation RTS.

The requirements were approved by an executive group consisting of parties to the project. The executive group acted as committee TK 320 of the Building Information Foundation RTS, and as such, participated actively in developing the content of the requirements and asking for comments from the members of the executive group and from interest groups.

Parties to the © COBIM project.

Table of Contents

1	Main objectives of building information modeling	3
2	Introduction	5
3	Contractors' Requirements for Building Information Models	6
3.1	Definition of BIM in Contract Documents	6
3.2	Defining delivery of building information models into Construction Production	7
3.3	Design on contractor's responsibility	8
3.4	BIM Management in the Construction Phase	8
4	BIM Utilization Possibilities in Construction	10
4.1	Defining BIM Requirements for the Construction Phase	10
4.2	Construction Schedule in BIM	10
4.3	Presenting Construction Status Information in BIM	12
4.4	Construction Site Area Modeling (Site Layout Plan)	13
4.5	Ensuring Safety at Construction Phase with help of BIM	15
5	Production Data Delivery into As-Built BIM	18
5.1	Documentation of Earth Construction and Foundation Engineering as 3D Model	18
5.2	Change Orders/design changes during Construction	19
5.3	Concealed Installations	19
5.4	Product Data of Building Parts Chosen by Contractor	20
5.5	Data Handover into Facility Management	21

1 Main objectives of building information modeling

Property and construction modeling aims to support a design and construction lifecycle process that is of high quality, efficient, safe and in compliance with sustainable development. Building information models are utilized throughout the building's life cycle, starting from initial design and continuing even during use and facility management (FM) after the construction project has concluded.

Building information models enable the following, for example:

- Provision of support to the investment decisions by comparing the functionality, scope and costs of the solutions.
- Energy, environment and lifecycle analyses for the purpose of comparing solutions, design and objectives of facility management follow-up.
- Design visualization and analysis of construction feasibility.
- Enhancement of quality-assurance and data exchange and making the design process more effective.
- Utilization of building project data during use and facility management activities.

To make modeling successful, project-specific priorities and objectives must be set for models and model utilization. Project-specific requirements will be defined and documented on the basis of the objectives and general requirements set in this publication series.

General objectives of building information modeling include, for example, the following:

- To provide support for the project's decision-making processes.
- To have the parties commit to the project objectives by means of using the building information model.
- To visualize design solutions.
- To assist in design and the coordination of designs
- To increase and secure the quality of the building process and the final product.
- To make the processes during construction more effective.
- To improve safety during construction and throughout the building's lifecycle.
- To support the cost and life-cycle analyses of the project.
- To support the transfer of project data into data management during operation.

“Common BIM Requirements 2012” covers targets for new construction and renovation, as well as the use and facility management of buildings. The minimum requirements for modeling and the information content of models are included in the modeling requirements. The minimum requirements are intended to be observed in all construction projects where the use of these requirements is advantageous. Besides the minimum requirements, additional requirements can be presented on a case-specific basis. Modeling requirements and content must be presented in all design contracts in a binding and consistent manner.

The publication series “Common BIM Requirements 2012” consists of the following documents:

1. General part
2. Modeling of the starting situation
3. Architectural design
4. MEP design
5. Structural design
6. Quality assurance
7. Quantity take-off
8. Use of models for visualization
9. Use of models in MEP analyses
10. Energy analysis
11. Management of a BIM project
12. Use of models in facility management
13. Use of models in construction
14. Use of models in building supervision

In addition to the requirements in his or her field, each party to a building information modeling project must be acquainted at a minimum with the general part (Series 1) and the principles of quality assurance (Series 6). The person in charge of the project or the project's data management must have comprehensive command of the principles of building information modeling requirements.

2 Introduction

Construction production needs building information models as initial data to complement design documents and as a basis for construction modeling (BIM-based construction planning). This section presents construction production needs for designers' building information models, modeling tasks for construction production and data delivery protocol for As-built modeling. The guidelines cover the tasks related to general contractors and MEP subcontractors' building information modeling.

Contractors utilize building information models in construction planning and construction phases in the following operations, for example:

- familiarization with the building and its design as well as data mining in the bidding, procurement, and construction phases
- quantity take-offs during the bidding phase and for purchases and production planning during the construction phase
- general coordination and data exchange during construction
- 4D scheduling of production, planning construction sequences and visualization of construction status
- merging of various design parties models for controlling MEP installation sequences and for constructability reviews
- structure position data exchange from BIM into measuring devices
- construction site layout planning and safety planning, such as fall prevention planning

In principle, BIM-based design and planning reduces problems on site, when designs of various design and engineering fields are coordinated in advance with the help of BIM. In addition, 3D-based planning delivers more accurate dimensioning in designs, including in elevations, and generates the preconditions for improved design of intersections, connections and other details.

The accuracy of the models is essential for the production: the designs are to be made technically correctly and checked by the designer, as well as coordinated with the other design areas. A simple technical common core is that the dimensions, position, and identifiers of modeled structures are correct. For example, the construction elements' type IDs must be correct, the construction elements must be modeled with the correct tools, and the model must not display any alternative solutions.

Building information models are not a substitute for drawings and other design/plan documents. It is essential that the design documents are consistent with the building information models and drawings are printed from models. Where appropriate, the drawings can be formatted to match the drawing standards' requirements, or to improve the readability of drawings, but the changes must be consistent with the building information model. Contractors use designers' models as the basis for a variety of production modeling tasks. The production model is not one precisely defined BIM, but for the time being, it is the generic name for all models which have been complemented with data related to some production management perspective. Examples of production models include 4D-scheduling models, and a BIM-based site layout plan containing both the building and the construction site. The production model may also contain several of different production plans in conjunction within the same file.

3 Contractors' Requirements for Building Information Models

3.1 Definition of BIM in Contract Documents

Requirement

The delivery of building information models to the contractor, the contractor's rights to use the models and modeling requirements regarding the contractor are defined in the contract documents.

Guideline

Building information model issues to be included in the contract procedures are primarily presented in building information model requirements, Series 11 Management of a BIM project. This section describes the procedures evaluated as being necessary for the contractor.

The definition of building information model disclosure in contract documents is designated for stating the position of building information models in the project, as well as stakeholders' responsibilities and the rights to use the models. The definition can be presented in the contract program or contract negotiation memorandum that will be included in the contract documents, for example.

The minimum definition can be suggested as: "The contractors have access to designers' up-to-date BIMs and BIM specifications." In addition, the contract documents should make it clear that the construction project utilizes BIM, and designated areas of design and engineering have been conducted by modeling, rather than producing the models as additional material separate from design documents.

A more accurate alternative is to identify building information models that are delivered as technical/official design documentation in contract agreement, and define the validity order of them in relation to other documents. Building information models and model specifications are identified the same way as other technical documents.

In addition, contract documents record the contractor's right to deliver the building information model to a third party such as a subcontractor enclosed with an invitation for tender, or to subcontracting firms undertaking the work. The contractor is required to submit any restrictions regarding the use and disclosure of the building information model to the subcontractor.

In addition to the disclosure of building information models, the contract documents state specified requirements for contractor's building information modeling procedures (see chapters 4 and 5), so that the requirements possibly influencing contractor's costs are presented in the invitation to tender. If modeling requirements are set for the contractor, the invitation to tender should contain BIMs as technical documents. The contractor must also have the opportunity to review the models before making a contract.

3.2 Defining delivery of building information models into Construction Production

Requirement

Building information models submitted for production purposes are identified and their use and quality assurance are noted in the parties' joint review. Procedures and practices related to the usage of the models are presented to the Contractor. In addition, the project stakeholders agree on the necessary audit procedures and events during construction period. The contractor presents for what purpose the BIMs will be utilized in production.

Guideline

In the contract negotiation phase, in connection with the design review process, a review is organized where the client, the chief designer, other designers and contractors state the available BIMs and the modeling software and versions used for producing the models. At the same time, model versions included in the contract agreement are stated. Both the original versions and the IFC versions of the BIMs are handed over to production.

The following issues shall also be stated in the review: the main contents of the building information models, the intended use and status/degree of readiness as well as the version of each model. These issues can be stated with help of the BIM specification, at the same time ensuring that the BIM specification is updated. In addition, any other building information model requirements and guidelines from the client to the designers, which have contributed to the content of the models and the use of e.g. identification codes, etc. shall be stated.

It shall be also stated in the review that the designers have conducted their own quality assurance as agreed, and the separate models have been coordinated by merging and clash checking the separate designers' models. At the same time, schedule, implementation and current state of any agreed corrections are ensured. Quality assurance-related documents need to be available to contractors, e.g. checklists in accordance with the BIM requirements, Series 6 Quality assurance.

The stakeholders agree on merging the separate models into a combined model, responsibilities for gathering all models and merging them, as well as the tools and the sub-models to be used.

In addition to the contents of building information models, the project parties agree on further tasks for each party and the associated procedures. These include, for example, progressive work with BIM revisions, specific publishing phases of models, update cycle patterns of models, distribution of models through the project bank/electronic data management system, change and version management, quality assurance, as well as related coordination tasks and responsibilities.

One section of the review process is to state the modeling tasks and software under the contractor's responsibility and other possible use and distribution of these production models.

The parties should also agree on what other data will be stored in the building information model, and who will define and store data in various models. These include, e.g. defining the design schedule in a model, presenting procurement packages, or the design status for the building parts in BIM.

Regarding other design documents, the project team states which drawings are printed out from models, and it is recommended that the source model is written down on the list of drawings.

The project parties agree on necessary additional BIM reviews based on the completion of information models and other special needs regarding the project.

The review of the building information models is to be documented in a meeting memo or similar.

3.3 Design on contractor's responsibility

Requirement

When the contractor is responsible for the BIM-based system unit design in a BIM project, the modeling must be integrated to other project-specific BIM design and engineering. Requirements regarding modeling of system units will be agreed upon on a project-specific basis.

Guideline

The contractor obligates system unit designers/engineers to approve and coordinate the system unit design with the client's designers according to contract and follow project-specific and general building information modeling guidelines. The contractor invites system unit designers for necessary BIM reviews and obligates system unit designers to follow agreed quality assurance procedures.

The client/chief designer must ensure coordination of the models related to system unit delivery with the rest of the project's design. As an example, a skylight for which the project architect merely decides the spatial requirement and some definitions, e.g. glass distribution of the window and quality requirements. Merging a system unit supplier's detailed design/engineering with other designs might also mean for example sprinkler nozzle placements or maintenance levels coordination, which requires merging the partial models and necessary changes to them.

3.4 BIM Management in the Construction Phase

Requirement

Building information models are maintained during the construction phase and they need to conform to the other design documents handed over to production.

Guideline

As drawings or other design documents change or are completed, the corresponding updated building information model is distributed at the same time. Model update intervals as well as drawings release schedules are agreed in the kick-off meeting. The model update intervals and drawing release schedules may diverge from another.

Simultaneously with the building information model update, changes to the model are recorded in the BIM specification and this is published together with the model and drawings.

If required, the location and content of changes can be visualized by comparing different BIM versions in modeling software and printing 3D views from the models.

Requirement

The contractor is obligated to report any evidence of the errors or omissions in the building information model to the respective designer and the project's BIM coordinator. The designer is obligated to correct the error and provide a new version of the building information model.

Guideline

Design field-specific building information model guidelines require that each party checks their own building information model before distribution, and the chief designer is also responsible for the compatibility of designs covering the models. However, if the models contain deviations, according to the good practice of construction, the party corrects deviations quickly to prevent the consequences of their effects.

Once the designer receives a notification of a deviation, the designer notifies other parties of the case, so that unnecessary additional costs will not be incurred for the other parties.

The designer must make corrections immediately or agree with other parties about making necessary corrections. If the parties do not consider it necessary to carry out minor corrections immediately, one can update the information about the deviation and the schedule for correction into the BIM specification.

4 BIM Utilization Possibilities in Construction

4.1 Defining BIM Requirements for the Construction Phase

Most of the BIM utilization methods used by contractors are related to the organization of production, for which the client does not traditionally have set specific requirements. For example, the construction schedule is required under the contract, but the content and format are not precisely defined.

This chapter describes the general utilization possibilities of the building information modeling during the construction period. These possibilities are presented as requirements below, but the required modeling tasks must be agreed upon unambiguously in each project.

The following chapters present the modeling tasks for the main contractor, with implications for other parties' project activities and the main contractor's fulfillment obligations. It should be noted that the contractors take advantage of building information models in many other operating situations. These include:

- Visualization and supervision of work with the help of building information models
 - Visualization is still the most important use for models in many different situations. The most important applications of visualizations in production planning and control are viewing/studying the building and structures, as well as task order planning and work coordination.
 - For more information, see: *Series 8 Use of models for visualization*
- Quantity take-offs
 - Quantity take-off from BIM speeds up cost engineering and outputs a more accurate result, provided that the modeling is done properly. BIM-based quantity take-off and quantity take-off lists based on ready-made report templates significantly reduce duplicate work, which improves the productivity of the construction in this respect.
 - For more information, see: *Series 7 Quantity Take-Off*
- Procurement
 - As building information models become more common, models and model-based quantity take-off lists will be used as subcontract tender material, which expands BIM use. Subcontracts may also include the supplier's model-based design/planning, which deals with issues presented in chapters 3 and 5 in this manual.

4.2 Construction Schedule in BIM

Requirement

Planned installation dates for designated structures and systems, which are critical for the project schedule, are recorded in the building information model. The BIM-based project schedule is distributed for other parties' use in an agreed format. The requirement is agreed upon on a project-specific basis.

Guideline

The BIM-based schedule is intended to complement the construction schedule given to the client and to control issues such as the order of detailing. The structures/work phases critical to the project schedule and thus scheduled into the model may include foundations, the structural frame and demolition work. The integration of the design schedule into BIM is also possible.

The BIM-based schedule may only be presented for modeled structures, and in accordance with the modeling accuracy of structural assemblies. Models are delivered to the contractor in a format that enables scheduling with available commercial software. The division of BIM objects according to production and scheduling requirements is a task that is agreed on separately if it is a demand for the designers.

The distribution format and procedure of the construction schedule for the use of other parties are agreed upon on a project-specific basis. Distribution can be made as a static model view generated from 4D-BIM, in which different color codes visualize building element implementation at different times, such as on different days, weeks or months, depending on the level of accuracy of the schedule. The following figure shows an example of the construction schedule presentation in BIM (Figure 1). This model view can be shared with other parties without the need for separate BIM-based software.

In the case of construction system unit procurement, where the supplier models and schedules the related share of work, the project participants need to agree upon presentation, distribution and the possible merging of the produced schedule with the main contractor's schedule.

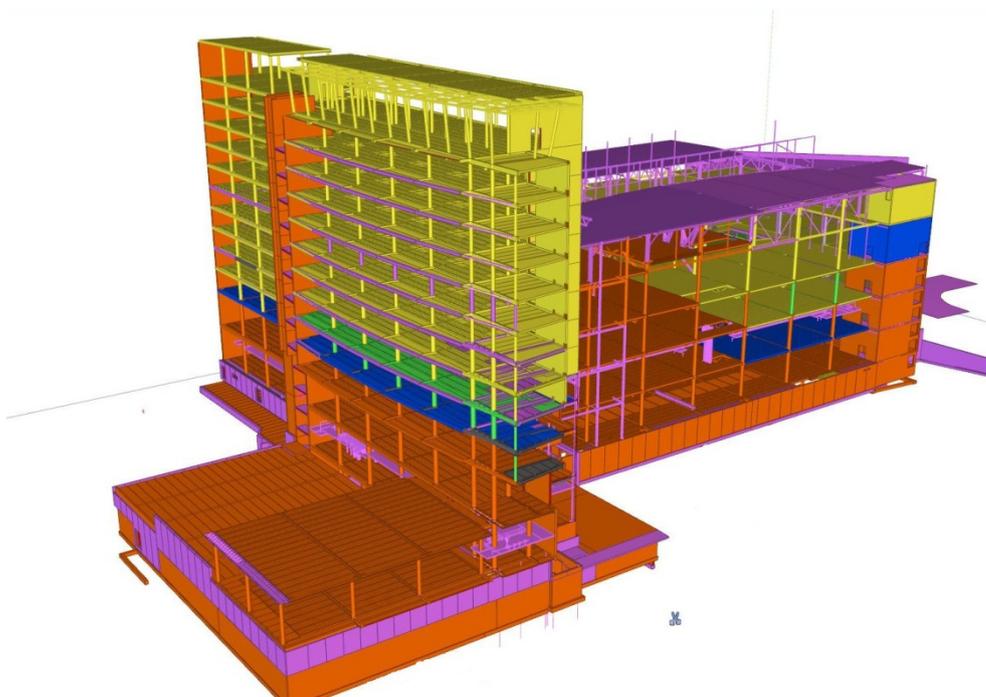


Figure 1: An example of a BIM-based schedule for construction work of a structural frame. Color codes: orange = completed/installed, blue = this week, green = next week, yellow = scheduled, in over two weeks, purple = scheduled, in over two weeks and a different contractor (Source: SRV, Flamingo project, Vantaa)

The construction schedule and maintaining it are the most interesting and closely followed issues in the project from the client's point of view. Presenting a schedule and the construction status with the help of BIM in construction site meetings, for example, is more visual than the traditional schedule presentation.

4.3 Presenting Construction Status Information in BIM

Requirement

Actual installation dates of structures and systems are recorded in BIM at agreed intervals, including parts of MEP systems. The viewing model visualizing construction status information is distributed to the entire project team in the agreed format and manner. The requirements are agreed upon on a project-specific basis.

Guideline

The status information can be updated and recorded into a BIM on daily or weekly basis. Construction status can only be presented for modeled structures, and in accordance with the modeling accuracy of the structural assemblies.

The distribution format, frequency and method are to be agreed concerning the viewing models representing the construction status. Distribution can take place at agreed intervals, e.g. as a static 3D model view corresponding to site status, that is, e.g. XML or a 3D PDF file delivered through the project bank/project information centers. The following figure shows an example of a BIM-based presentation of construction status information (Figure 2).

In addition to construction status, a model view can be used to present structures to be constructed in the next period.

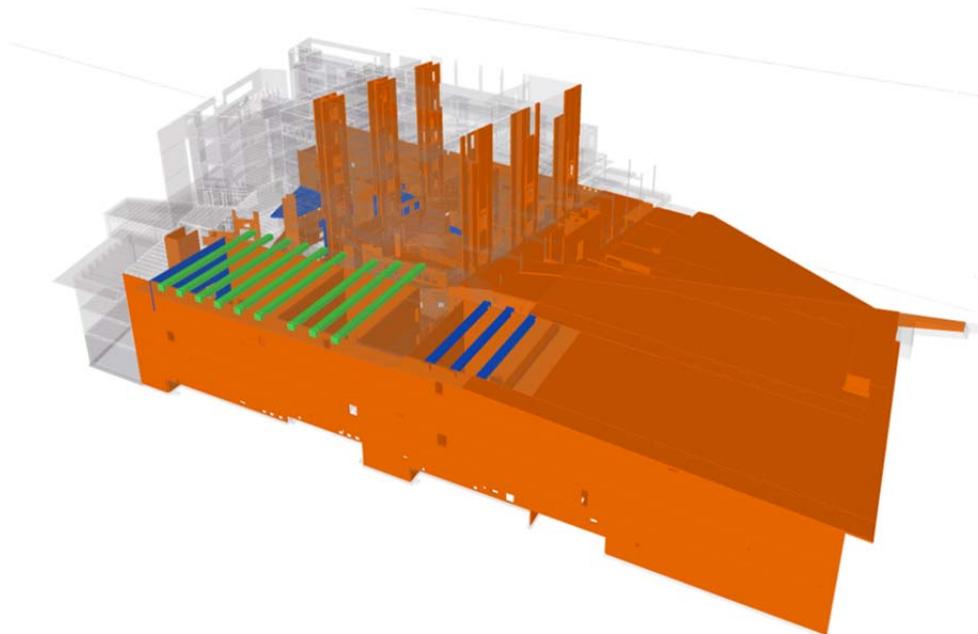


Figure 2: An example of a BIM-based construction status representation. Color coding as in the previous figure. (Source: SRV, Helsinki Music Centre, Helsinki)

4.4 Construction Site Area Modeling (Site Layout Plan)

Requirement

The contractor prepares the construction site layout plan/site area plan as a 3D plan. It must be agreed upon on a project-specific basis, for which work phases a site layout plan is required.

The site layout plan also shows all issues required in a traditional 2D plan, such as the construction site area (lot) with buildings and all temporary construction site equipment, walkways and space reservations as either accurate presentations (3D objects/construction components) or simplified 3D blocks. Regardless of the precision level of modeling, it should be carried out so that the construction components are visually identifiable in the plan.

Adjoining/connecting street areas and e.g. other buildings and structures in the crane extension area are presented to the extent where the construction site could have an impact on its environment (e.g. the effects on public pedestrian or vehicular traffic).

The requirements are agreed upon on a project-specific basis, and the preparation of ground surface model will be agreed.

Guideline

An architect or structural engineer's model can be utilized as a basis for the site layout modeling. The starting point in this case is the building model, which contains all the necessary building elements, and is further processed as on-site modeling. Alternatively, the designer's model can be used as a reference model in the construction site layout plan developed by the contractor.

In order for the 3D site layout plan content to be easily understood and also available as a traditional 2D drawing (2D model view), the objects shall be connected with the necessary text explanations and additional information (such as the sorting of different types of waste). This needs to be done regardless of whether the modeling has been carried out as rough area reservations (for example, 3D sheets or blocks), or by using 3D objects which are visually easier to interpret.

If the objects included in the plan need to be identifiable with software, this is agreed upon separately.

The 3D site layout plan is updated throughout the entire construction phase as construction work progresses on site, and the aim is as real-time a 3D model of the site plan as possible.

The site layout plan presents the site area usage for different activities and the location of site operations that support the main activities, the main contents being:

- site area, adjoining streets and other immediate surroundings that the construction site may impact
- temporary structures and equipment, such as site office and storage facilities, fences, walkways and machinery

- temporary site situations, such as excavations and area reservations for material storage.

In addition, the BIM-based 3D site layout plan can be used for visualizing risk areas or reach zones of machines such as crane reach or danger zones, for example.

The site layout plan conveys information about the construction site's internal and external logistics arrangements as well as work and safety arrangements for all project parties. Pedestrians' guidance through temporary walkways and protected passage routes are part of construction site safety planning, and modeling facilitates the presentation of these solutions to the client. The following figures show examples of construction site area usage modeling.

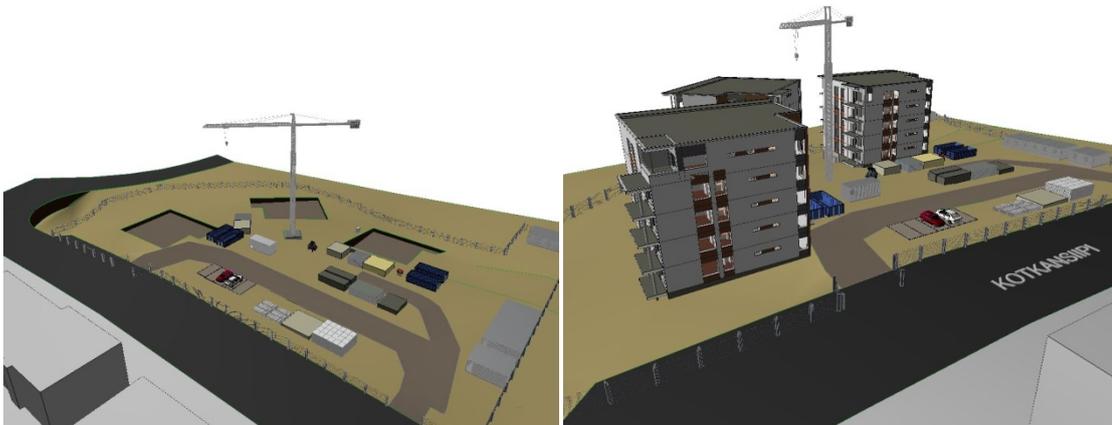


Figure 3 An example of a 3D site layout plan for the excavation and framework phase. (Source: VTT)

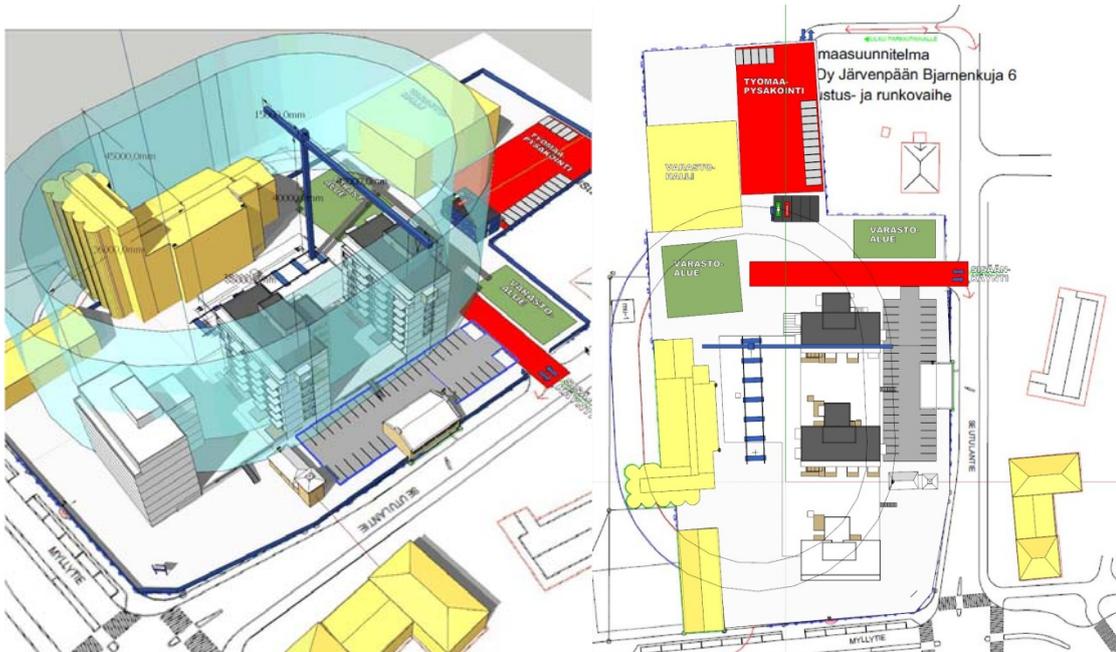


Figure 4 An example of a 3D site layout plan, a perspective view and a 2D view from the same model. (Source: NCC Ltd, Condominium Järvenpää Bjarnenkuja 6)

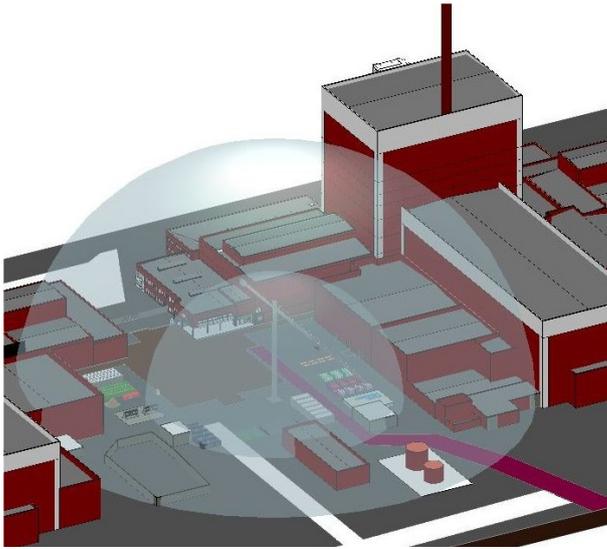


Figure 5 Example of the use of a 3D site layout plan for modeling the danger zone and visualizing crane fall analysis. (Source: VTT)

4.5 Ensuring Safety at Construction Phase with help of BIM

Requirement

Contractors responsible for construction work of the project and the structural engineer review the precast concrete element (or prefabricated steel part) installation plan and cast-in-place structures together with help of BIM, and accept the main installation orders, temporary supports and structures, bracing and formwork systems.

Main contractor presents solution types for fall prevention for approval with the help of a 3D model. Modeling is implemented to at least the level of accuracy and extent agreed with the client.

The main contractor and the structural engineer collaborate in checking the fastening parts and other provisions in the structural model related to occupational safety, such as safety harness attachment points and attachment points for railings on structures.

The contractor marks the temporary storage locations for loads exceeding the agreed threshold value, as well as the weight of materials planned for storage on vaults, and then sends the plan to the structural engineer.

The requirement is agreed upon on a project-specific basis.

Guideline

Options for modeling safety railings are e.g. a BIM-based detailed representation of the desired safety railing solution, or modeling of a limited area, such as one story of a building. Safety modeling is carried out in the structural model or structural plans are used as initial data, if the structural model is not available or modeling related to occupational safety is conducted with different software than the structural modeling.

Geometrically accurate railing type modeling can also specify/complement the traditional railing plan, e.g. when there are different types of safety railings marked with different colors to the traditional 2D drawing, and each solution type is visualized in principle with detailed 3D modeling.

Precast element bracing is modeled and the main contractor and the structural engineer inspect the positions for safety and logistical constraints together. The positions of braces are inspected, so that wall panel bracing has the required counter support point on the vault. The model can also be used for checking and avoiding conflicts between the bracing and construction site logistics, such as unreasonable complications in passageways or the temporary storage of materials on vaults.

The presented critical temporary storages may include e.g. temporary storage loads close to the calculated structural live load on vaults, or construction machinery.

Construction safety can be improved with the help of BIM in three phases:

- 1) by planning and modeling the construction work in advance, as well as the necessary related safety precautions/arrangements and equipment that will be used in different phases of the site process,
- 2) by ensuring that the structure can be constructed safely, and that the necessary fastening parts/details for fixing the planned safety equipment have been designed and modeled into structures, and
- 3) the planned safety solutions have been adequately visualized in documents.

Information exchange with the person responsible for safety solutions implementations is ensured with site staff orientation and supervision. 3D presentation supports safety-related communication and the presentation of the planned guardrail solutions with help of model to employees can significantly ease transmitting information and understanding.

Safety planning is particularly related to work sequence planning and should therefore be part of the 4D scheduling of construction parts that are permanently installed into a building. Safety planning is also related to structural engineering, as the mounting of safety equipment may require factory installed parts into prefabricated construction elements, for example. In addition, a building's overall stability and individual part usability as a safety harness attachment point may require structural expertise.

Occupational safety and health solutions which can be modeled include guardrails used for fall protection, hole covers, harness attachment points, and safety nets (Figure 6 and Figure 7).

BIM-based safety planning can be implemented geometrically accurate, such as when railing parts are visually identifiable as a certain type of railing post and net components or timber railings related to the safety railing system. Modeling can also be implemented in a merely illustrative/rough manner, e.g. a certain kind of safety railing can be presented as a single block/panel by using a certain color. However, accurate modeling is the recommended method.

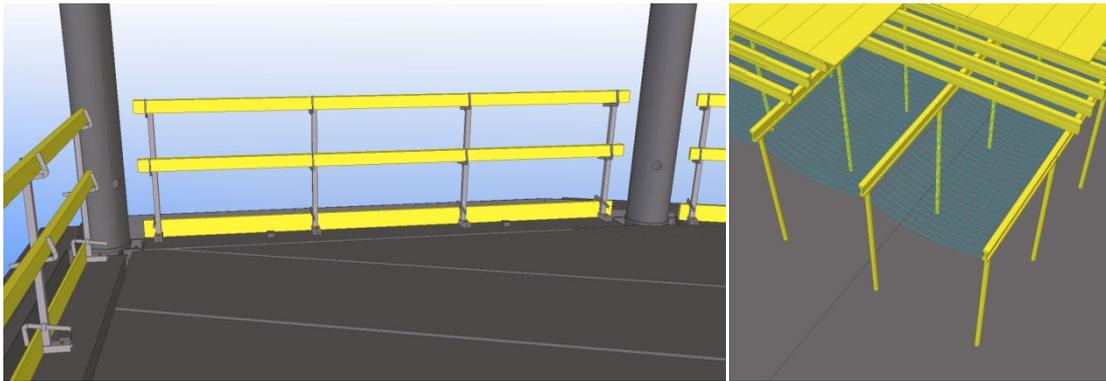


Figure 6 The image on the left represents an example of a principal presentation of a safety railing solution with help of BIM, and the image on the right is a presentation of a safety net solution. (Source: VTT, Skanska)

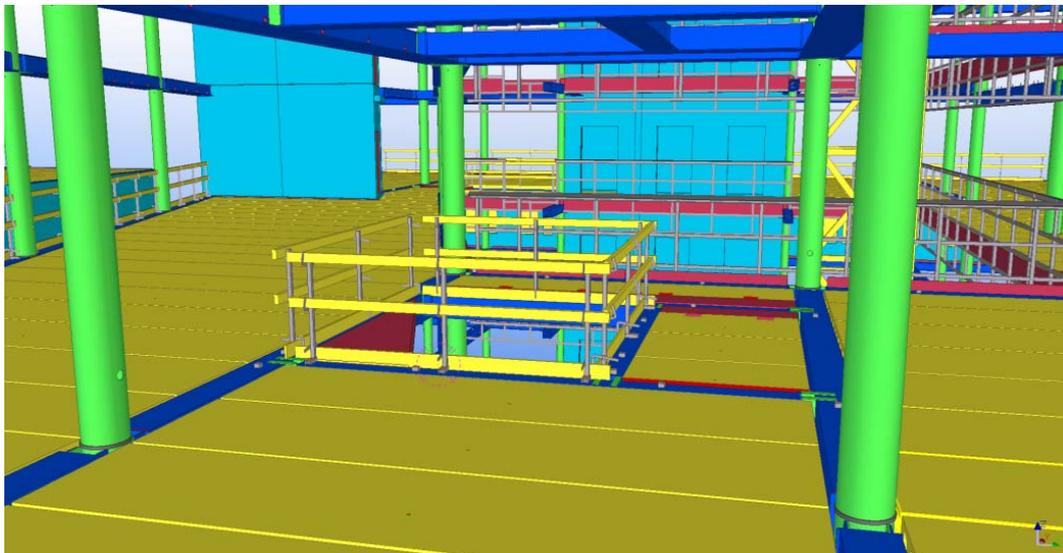


Figure 7 An example of a BIM-based safety railing plan modeled into one story of a structural model. (Source: VTT, Skanska)

5 Production Data Delivery into As-Built BIM

The principle is that when the client is responsible for the design, the contractor submits the as-built production data to designers, who compile as-built models. Model-related as-built data processing, and requirements for data are presented more specifically in the following chapters.

A requirement for the contractor to provide production information for as-built BIM is already defined in the invitation for tenders.

In case of system unit procurement, the supplier is responsible for an as-built model for its own product, and the client or the client's representative such as the chief designer is responsible for merging the system unit as-built models with designers' as-built BIMs.

5.1 Documentation of Earth Construction and Foundation Engineering as 3D Model

Requirement

The building excavation is laser scanned and modeled, and the model is stored as as-built data and that can be used for the BIM-based production planning. Scanning and the possible modeling based on the scanning results are implemented as defined in the invitation for tender/in contract.

Scanning and models are made in earth construction and foundation engineering intermediate phases as defined in the invitation for tender/in contract.

Guideline

In addition to the building excavation, scanning and modeling may be necessary or useful for documenting some of the intermediate phases of construction work. These issues to be documented may include pipes and wires, or concealed critical construction elements on site (Figure 8).

The point cloud output as the scanning result does not necessarily need to be processed in any way, before it is necessary to go back in time due to errors, subsidence, or issues related to progress of the construction work.

Laser scanning of the building excavation and the surface model based on the scanning is valuable as-built data to the client. However, the importance of the as-built data to the client depends on the nature of the project.

The main contractor can use the model made from the excavation for modeling production tasks and documenting the starting point of the building construction. This data can be used later for comparison between the actual extent of earth construction work and quantity information in tender documents.

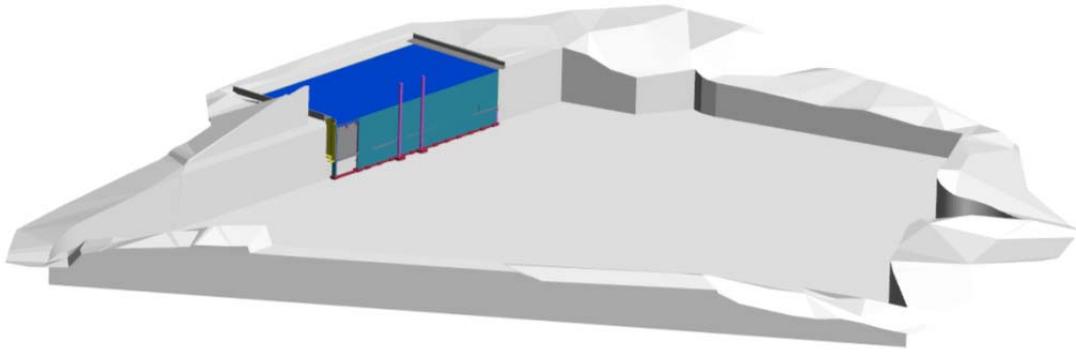


Figure 8 An example of a building excavation model. (Source: SRV, Kalasatama project, Helsinki)

5.2 Change Orders/design changes during Construction

Requirement

The main contractor delivers the necessary data concerning approved design deviations/changes made during the construction process to designers for an as-built model update.

Guideline

Contractor provides the required information of all design changes that are approved according to the contract.

If needed, the location and content of changes can be visualized by comparing different BIM versions in modeling software and printing 3D views from the models.

Changes made during the construction phase can be documented with the help of laser scanning or photographs as an alternative to modeling. Required documentation of the changes by the contractor is defined on a project-specific basis.

5.3 Concealed Installations

Requirement

The contractor delivers the as-built position and geometry data (results of checking measurements) of concealed structures for designers for an update of the as-built model as required in contract documents. Verified measurements within the limits of installation tolerances are not required.

Guideline

Photos are taken from concealed MEP installations.

The precision of as-built data cannot rely on the tolerances in MEP installations, because the MEP components do not have defined installation tolerances.

In practice, a reasonable tolerance requirement must be considered on a project-specific basis which also depends on where and what size the MEP component is.

Special attention must be paid to the accuracy of position information related to concealed valves, service hatches, pipes and duct branches in the as-built model.

Major position changes of pipe and duct lines and wire routes are recorded in the as-built model.

5.4 Product Data of Building Parts Chosen by Contractor**Requirement**

The contractor delivers geometry and product data concerning building parts it has chosen to be updated to the model, if they differ from the data defined in the As-Designed model. Information is delivered to the designer immediately after the products are known with certainty, and they are approved by the client.

If the building product chosen by the contractor has an impact on the rest of the design, e.g. if it requires a recalculation of MEP systems (pressure drops, balancing and preset values/damper positions), the MEP engineer makes recalculations and the contractor agrees on the commission with the client.

Guideline

Changes are updated to the model and the updated model or information concerning the change is delivered to all parties. As a result, up-to-date BIMs are available for clash detections and the information is instantly updated as as-built data.

If a detailed 3D geometry for the building product chosen by the contractor does not exist as a real product model, the designer can use a similar product or a general 3D component with the right dimensions. In both cases the component needs to be identified with the necessary product information.

The contractor delivers all changes requiring recalculation of MEP systems to the designer as early as possible to avoid the need for several recalculations.

In case of system unit delivery, the supplier is responsible for modeling and any changes/refinements to their own product.

5.5 Data Handover into Facility Management

Requirement

The contractor delivers information on construction elements, equipment and materials for the maintenance phase in the form defined in the contract. The minimum data exchange requirement is the document format (PDF, Excel). It can be agreed within each project that product data, such as manufacturer, type, technical specifications, etc. are delivered in a facility management software-compatible format.

Guideline

Delivery of the contractor's product data is discussed in Series 12. Use of models in facility management.