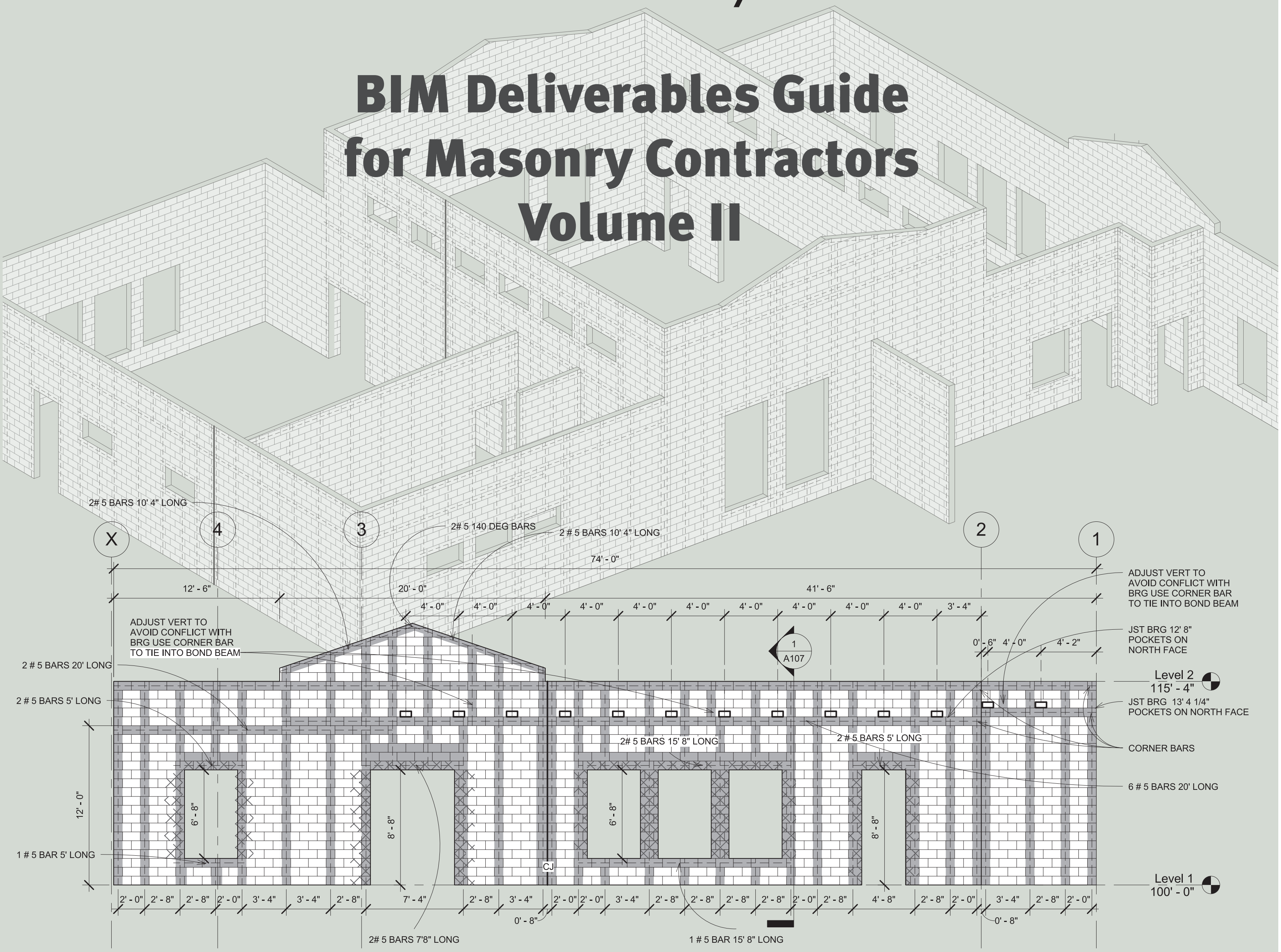
# BIM-M

## Building Information Modeling for Masonry

# BIM Deliverables Guide for Masonry Contractors Volume II

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# BIM Deliverables Guide for Masonry Contractors Volume II

## Table of Contents

# Introduction
# Purpose of BIM-M Volume II

In January of 2016, BIM-M released the first volume of its *BIM Deliverables Guide for Masonry Contractors*. The purpose of that document was to act as a resource for mason contractors, to demonstrate to them the value of BIM and to encourage them to participate in the BIM process.

The initial guide highlighted "Deliverables" that could be obtained by creating a model of the masonry for the benefit of mason contractor's. It discussed how using specific "Deliverables" could help a contractor attain goals as detailed in a BIM Execution Plan (BXP) created by the contractor. Some examples of how BIM can be of help included improvements in production, schedule and supply chain management. Improvements in these aspects of a project translate into an increase in profitability and competitiveness for the contractor, and an increase in market share for the industry as a whole.

The purpose of Volume II of the *BIM Deliverables Guide for Masonry Contractors* is to share a number of case studies featuring specific projects. These case studies show examples of 3D and BIM models created by contractors or BIM providers.

The case studies examine "Deliverables" obtained from each model, and show how "Deliverables" were able to improve workflows on each project. Specifically, they indicate how each deliverable provides value to the contractor making them more efficient and therefore more profitable.

The case studies that were chosen utilized various BIM software programs available such as Trimble's SketchUp, Autodesk's Revit, Tekla and CAD BLOX, which is a third party service vendor.

All of the case studies were provided by contractors. The information provided by the models was meant to be used by the mason contractor or general contractor self-performing the masonry. In many cases, if the information was relevant it was shared with the complete project team. This will be talked about in greater detail in the Information Exchange and Workflows section of this document.

# Examples of Deliverables

The following "Deliverables" were listed in the first volume of the *Deliverables Guide for Masonry Contractors* and apply to this volume as well.

- Material quantities for purchase orders
- Shop drawings
- Virtual mock-ups
- Create RFIs for unworkable details
- Layout
- Rebar size and placement
- Heights and coursing
- Create lift/working drawings
- Equipment and scaffold requirements
- Site Logistics

Those "Deliverables" will help the contractor reach goals that may have been outlined in their BIM Execution Plan (BXP). If there is no BXP, the objective of the "Deliverables" may be to accomplish company goals for every project such as:

- Improve production
- Improve quality
- Improve schedule
- Improve safety
- Better utilization of equipment
- Improve communication between office and field
- Improve communication with CM/GC
- Improve communication with A/E

The case studies in Volume II will show specifically how the "Deliverables" provide value, improve workflows and increase efficiency for the contractor and the project as a whole.

# Information and Workflows

As discussed in Volume I of the *BIM Deliverables Guide for Masonry Contractors* the "*I*" in BIM stands for information. How this information, which is typically gained through the implementation of the "Deliverables," is used and distributed is critical to reaching the goals. The following chart is an example of an "Information Exchange" that might be typical for any project. When viewed in the context of the case studies, it will become evident how the Information Exchange can affect workflows, improve production and manage the supply chain.

| Information Exchanges | | | | | | | |
|---|---|---|---|---|---|---|---|
| **"Deliverables"** | **Foreman** | **Labor Foreman** | **Material Supplier** | **CM/GC** | **Architect** | **Sub Foreman** | **Equipment Manager** |
| Material Quantities | ● | ● | ● | | | | |
| Shop Drawings | ● | ● | ● | ● | ● | | |
| Virtual Mock-ups | ● | | ● | ● | ● | | |
| Clash Detection | ● | | | ● | ● | | |
| Unworkable Details | ● | | | ● | ● | | |
| Layout Drawings | ● | ● | | ● | | | ● |
| Rebar Size & Placement | ● | | ● | | ● | | |
| Heights & Coursing | ● | ● | | | | ● | |
| RFIs | ● | | | ● | ● | | |
| Lift Drawings & Work Instructions | ● | ● | | | | ● | |
| Equipment & Scaffold Requirements | ● | ● | | | | | ● |

***Figure 1:*** **From *BIM Deliverables Guide for Masonry Contractors* Vol. 1 presentation**

# Software Utilized for Case Studies

The case studies contained in Volume II are examples of how contractors use the various software programs and services available to accomplish goals.

**Revit**

***autodesk.com/products/revit-family/overview***

Revit by Autodesk is used in a number of the case studies. It is used by approximately 70% to 80% of the A/E's, and by a large portion of the CM/GC community. The mason contractors choosing to use Revit to create their models have no problem sharing their models with the A/E's and CM/GC's or any of the other trades such as the mechanicals and steel suppliers, who often are also using Revit. This makes functions such as clash detection seamless.

**SketchUp Pro**

***SketchUp.com/products/SketchUp-pro***

SketchUp Pro by Trimble is also used in a number of the case studies in Volume II. Because of its reasonable price, ease of use and geometric accuracy, it is widely used by mason contractors who want to produce 3D modeling. By creating a DWG file or an IFC, the model can be incorporated into a Revit model for functions such as clash detection. BIM–M is also working on plugins that will allow a SketchUp model to be interoperable with a Revit model.

**Tekla Structures**

***tekla.com/products/tekla-structures***

The third software that is highlighted in the case studies is Tekla Structures. Tekla is the parent company of SketchUp and Trimble. Tekla Structures is seen as SketchUp's more powerful big brother. It has many of the same features and can share a SketchUp database, but it can also build a model more efficiently and with more detail and information. Tekla Structures, unlike Revit, is predominately a construction-based software. It is used heavily by concrete and steel contractors because it has the ability to provide the level of detail required by contractors to ensure accuracy in the field. The good news is that Autodesk and Tekla reached an agreement in 2016 to ensure interoperability between their products. This bodes well for the industry as a whole.

**CAD BLOX**

***cadblox.com***

One case study in this guide was developed using CAD BLOX from a third party BIM provider that uses AutoCAD. Because AutoCAD is an Autodesk product, as is Revit, there is some interoperability between AutoCAD and Revit. Using a service provider firm such as CAD BLOX is an option for contractors who do not want to, or are unable to, create their own models, however still want to make use of the "Deliverables" that will help them to be more productive.

# Case Studies

The following case studies highlight masonry models created by mason contractors for their use. While most of the projects' models were created without a formal BIM Execution Plan (BXP), the contractors had identified goals for each project, and chose specific "Deliverables" they used to meet them.

# #1
# Case Study

**CASE STUDY #1**

**Project:** Manufacturing Facility
**Architect:** Lindhout Associates Architects
**CM/GC:** O'Neal Construction
**Mason Contractor:** Davenport Masonry Inc.
**Software:** SketchUp

This is a manufacturing facility. The mason contractor created a SketchUp model for their own use. There was no BIM requirement, BIM coordinator or BIM execution plan. The mason contractor did not share their model with anyone else, it was created solely for their use.

**"Deliverables" Utilized:**

- ***Material Quantities***
- ***Shop Drawings***
- ***Rebar Placement***
- ***Create Lift/Working Drawings***

The "Deliverables" were used to improve the following on this project:

- Production
- Schedule

The use of the "Deliverables" allowed for a smooth workflow eliminating delays. This has a direct impact on the production and the overall schedule.

This contractor states they will continue to model their projects because of the improvements to workflows and processes. The contractor's goal of being the preferred resource of the CM is directly related to these improvements.

# #2
# Case Study

**CASE STUDY #2:**

**Project:** Southeast Health Group Building Expansion
**Architect:** HGF Architects Inc.
**CM/GC:** Houston Construction
**Mason Contractor:** Mountain Masonry LLC
**Software:** Revit

This project is a building expansion consisting of approximately 8,000 CMU. An interesting fact is that the Revit model was created by the mason contractor during the bidding phase of the project. This is contrary to other examples we have listed in this guide. Models are typically created after the award of the contract and not during the bidding phase. There was no BIM requirement, BIM coordinator or BXP for this project.

**"Deliverables" Utilized:**

- ***Material Quantities:*** The model was created during the bidding phase to generate a very accurate take-off.
- ***Shop Drawings:*** During the construction phase, the use of shop drawings created by the model simplified the drawing set from over 400 pages (most of which were not applicable to the masonry) to three pages.
- ***Virtual Mock-ups:*** While there was no virtual mockup required in the contract, the 3D image created in the shop drawings helped to make visualization of the building easier.
- ***RFIs:*** The contractor was able to propose moving windows and a gabled parapet before construction started. Once accepted by the design team, this avoided costly delays that would have occurred if these issues were not addressed once construction was underway.
- ***Rebar Placement:*** Once awarded the job, rebar shop drawings were created from the model showing the proper layout. This allowed the supplier to precut most of the rebar thereby eliminating most of the jobsite cutting. Having the proper layout saved time, and also ensured uninterrupted grout cells. At the end of the project, the rebar shop drawings can be incorporated into the "As Built Drawings" so that for any future modifications to the building, the grout cores and bond beams will be shown.
- ***Heights & Coursing:*** All top of wall, opening sizes and bearing plate locations are shown saving a huge amount of layout time.
- ***Create Lift/Working Drawings:*** Each grout lift is detailed in the drawings created from the model. This streamlined the inspection process and made it easier for the foreman to determine the correct amount of grout.
- ***Equipment/Scaffold:*** Scaffold quantities were figured from the model and drawings. Sequencing was not planned for this project.

Use of the "Deliverables" allowed the contractor to see improvements in the following:

- Production
- Schedule
- Site Logistics
- Supply Chain Management

The information, the "I" in BIM, was shared with the architect, the CM/GC, material suppliers, other trades and internally within the company with the foreman and crews.

The contractor stated they will continue to model projects they are bidding on. In their opinion, the accuracy of the estimate and the knowledge gained during the modeling process far outweigh any additional costs that are incurred. If the bid is successful, having the model completed gives them a head start on the project.

As far as improving the process, the contractor would like to see more coordination among the trades coming from the GC/CM. They have started to coordinate with other trades on their own such as comparing the electrician's model with their own model for clash detection.

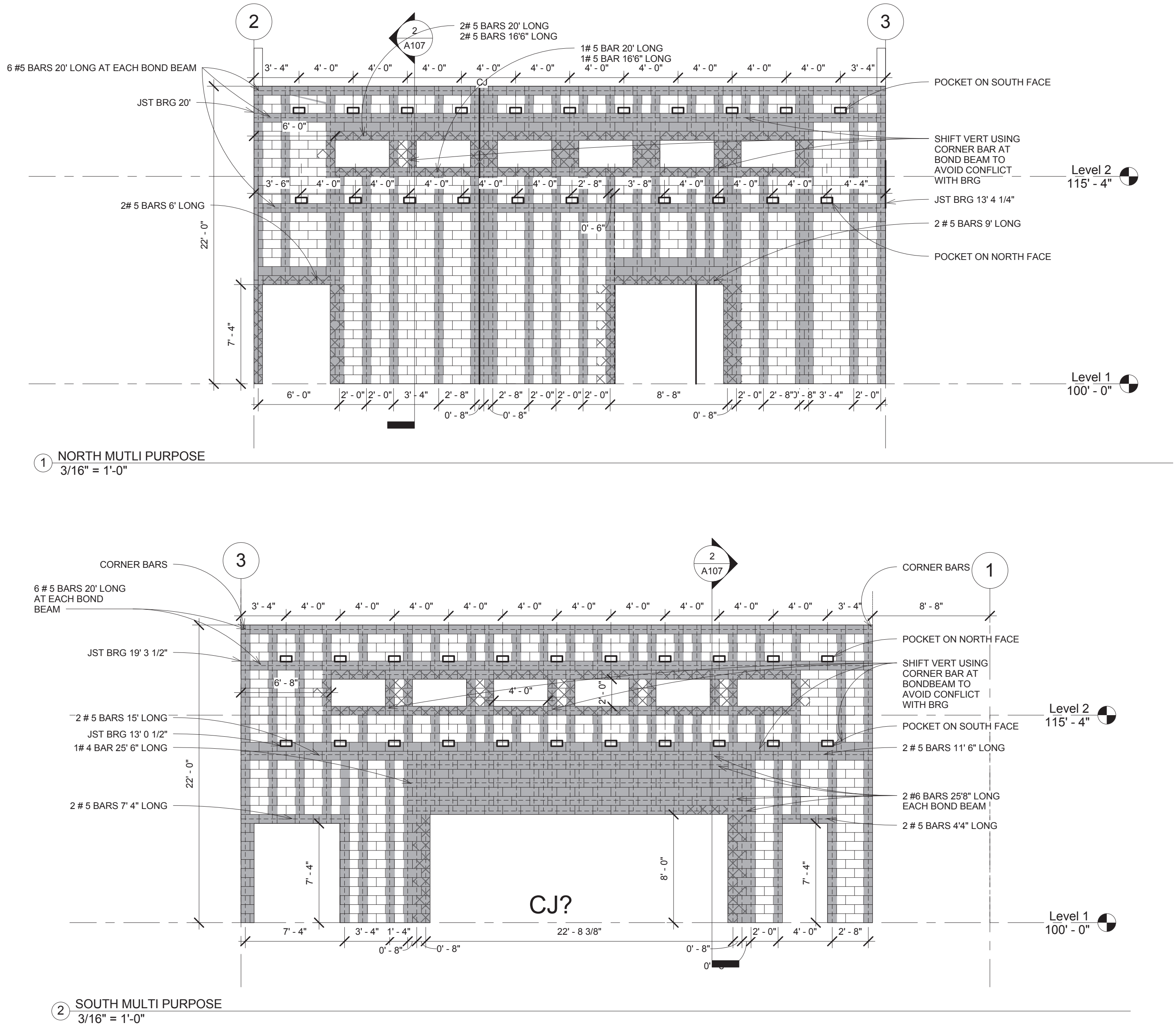


*Figure 1:* **S.E. Health Group Building Expansion 2D lift drawings generated by Revit model showing grout, rebar, bond beam and joist pocket locations**

# #3
# Case Study

**CASE STUDY #3**

**Project:** Occhiato University Center, Colorado State University-Pueblo
**Architect:** Hord-Coplan-Macht
**CM/GC:** Nunn Construction
**Mason Contractor:** Mountain Masonry LLC
**Software:** Revit

This project was an addition to an existing building consisting of 4x8x16 brick and glazed CMU. There were two colors of brick and one color of glazed CMU. A Revit model was created during the bidding phase and was used to create the estimate. There was no BIM requirement in the contract documents, no BIM Execution Plan or BIM coordinator on the project. The modeling was solely the choice of the mason contractor.

**"Deliverables" Utilized:**

- ***Material Quantities:*** The model was created during the bidding phase of the project and produced a very accurate material take-off.

- ***Shop Drawings:*** The model allowed the contractor to create shop drawings that were relevant to the masonry deleting a lot of the details that were not applicable to their work.

- ***Virtual Mock-ups:*** The mason contractor created a virtual mock-up of a window detail to show how a special brick would look at the jamb. This streamlined the process of approving the special brick. It provided the layout for the bricklayers in the field.

- ***RFIs:*** Based upon information from the model, the contractor submitted an RFI before construction started regarding window locations. This RFI allowed them to move all of the windows 4 inches, which made the bond work out and eliminated small pieces of brick. If this RFI had not been generated during the preconstruction phase, these changes would not have occurred. This would have negatively affected production as well as the appearance of the project.

- ***Heights & Coursing:*** The shop drawings detailed transitions in materials, shelf angle locations and top of wall.

- ***Create Lift/Working Drawings:*** The contractor had a set of shop drawings laminated and available on site for the foreman's use. Future plans by the mason contractor to use tablets versus paper copies are in the works.

- ***Equipment/Scaffold:*** The contractor created a drawing detailing the starting point, how much scaffold was required and how it was moved to the next location. This allowed for coordination with the spray foam contractor for installation of the foam, which was to be installed prior to brick installation.

- ***Site Logistics:*** There was limited storage space on the project site. The model allowed the contractor to break down material quantities by wall or elevation. This breakdown allowed the contractor to plan to have enough material on hand for each of the walls as they were built. Utilizing just-in-time delivery through modeling minimized congestion on the site.

The detailed information provided by the "Deliverables" allowed the contractor to see improvement in the following:

- Production
- Schedule
- Site Logistics
- Supply Chain Management

The model, and the information it provided, was shared with the architect, CM/GC, material suppliers, other trades and with the crew and foreman. The examples show how “Deliverables” and the sharing of information improved the workflows and work processes on this project. Based on that information, the contractor said they will continue to model the projects they are involved in.

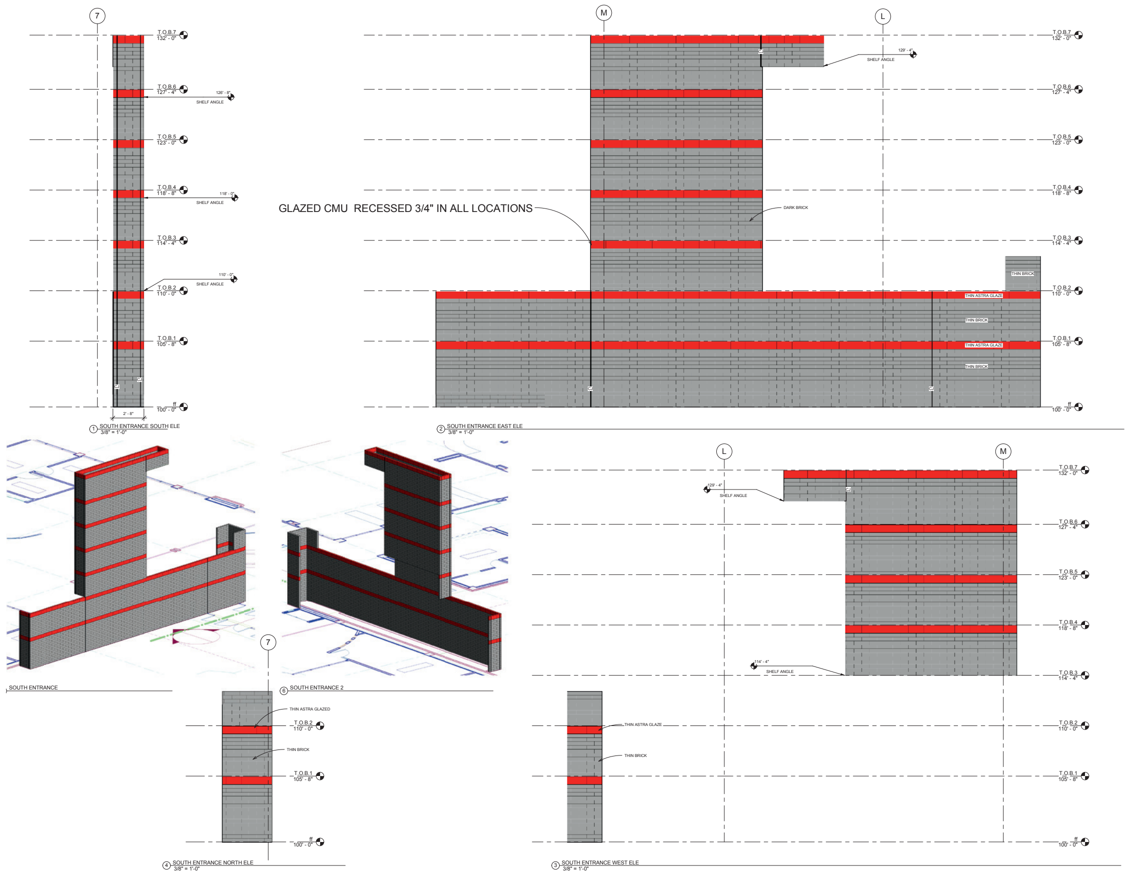


***Figure 2:*** **Occhiato University Center 2D and 3D drawings generated from the Revit Model showing brick and Astra Glaze CMU locations and layout**

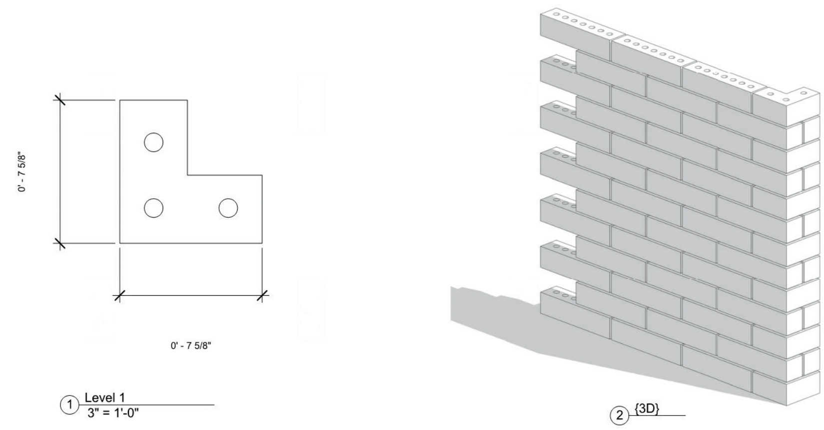


***Figure 3:*** **Occhiato University Center shop drawing of special shape return brick generated by Revit model**

# #4
# Case Study

**CASE STUDY #4**

**Project:** Washington High School Auditorium Addition, Washington, IA
**Architect:** SVPA Architects Inc.
**CM/GC:** Carl A. Nelson
**Mason Contractor:** Seedorf Masonry, Strawberry Point, IA
**Software:** Revit

This project was an auditorium addition to an existing high school, which incorporated two colors of burnished CMU, burnished sound CMU and integral colored smooth and split faced CMU. A Revit model created during the preconstruction phase was used to coordinate the various CMU types on the project. There was no BIM requirement, BIM Execution Plan or BIM coordinator on the project.

**"Deliverables" Utilized:**

- ***Material Quantities:*** A main objective of the model was to generate an accurate quantity take-off of the various types of CMU and their respective special shapes.
- ***Shop Drawings:*** Shop drawings obtained from the model were submitted to the construction manager and architect for final approval, and were then used by the field employees for layout.
- ***RFIs:*** RFIs concerning layout issues were created during the modeling process. With these issues being resolved, it allowed accurate material ordering. Resolution of these layout issues before construction meant that the field had no delays while waiting for answers during the construction process.
- ***Heights & Coursing:*** This project had multiple floor lines, and most of them were at a rake. The model and shop drawings helped the field contractors identify where CMU types changed from burnished one face to burnished two faces.

Use of the above "Deliverables" allowed the contractor to see improvements in the following:

- Production
- Supply Chain Management

The contractor's original goal was to use the model to obtain an accurate material take-off, and to be able to better visualize the various CMU types, floor lines and ceiling heights. The model also allowed the contractor to generate a schedule that gave an exact piece count on each type of unit.

The model was also used to generate shop drawings showing the locations of the various types of CMU so the architect could approve before ordering the CMU and the start of construction.

There were other unintended benefits derived from the modeling that improved the overall quality and production on the project. Other information that was provided by the model included layout issues that were discovered before the construction process. In addition, the model provided missing dimensions that were not provided on the plans. The 3D model was available to the foreman and crew as a quick reference to simplify the complex layout. The shop drawings made sure that layout coincided with the material order put together by the project management staff eliminating the potential for costly delays.

The contractor would like to continue to model masonry on their projects. Due to the cost, they are limiting their modeling to their more complex projects at this time.

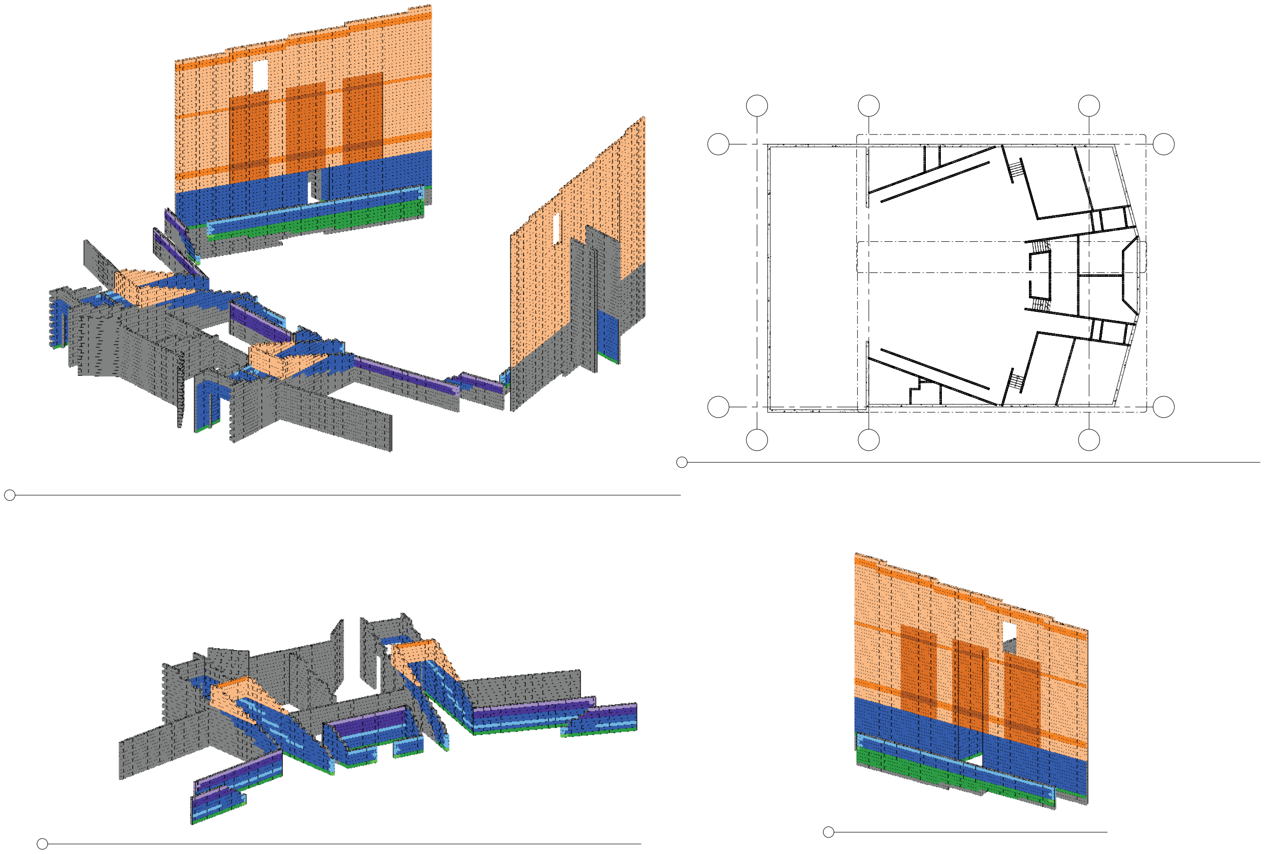

***Figure 4:*** **Washington High School 3D model showing different CMU types and locations generated by Revit model**

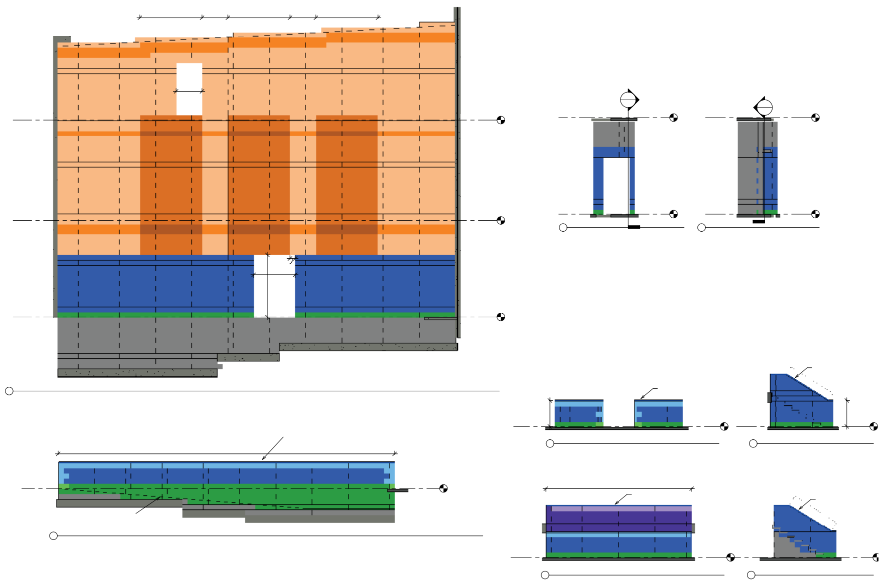

***Figure 5:*** **Washington High School 2D lift drawing showing CMU types and layout generated from Revit model**

# #5
# Case Study

**CASE STUDY #5**

**Project:** Fire Station, Davenport, IA
**Architect:** The Galante Architecture Studio, Cambridge, MA
**CM/GC:** Bush Construction, Davenport, IA
**Mason Contractor:** Seedorf Masonry, Strawberry Point, IA
**Software:** Revit

The Davenport Central Fire Station consisted mostly of burnished CMU. A Revit model was created to get an accurate quantity on the burnished units.

There was no BIM requirement, BIM Execution Plan or BIM Coordinator for this project.

**"Deliverables" Utilized:**

- ***Material Quantities:*** A schedule of the different types of burnished CMU shapes was created from the model during the preconstruction phase, which was used to create a purchase order.
- ***Shop Drawings:*** Shop drawings utilizing different colors for the various shapes were created along with the 3D views. This saved time during layout, and made it easier for the foreman and crews on the jobsite.
- ***RFIs:*** RFIs were created from the shop drawings prior to ordering the material and being on site. This allowed for better workflows overall on the project.
- ***Heights & Coursing:*** Again the use of the shop drawings created from the model and viewing the 3D model allowed the foreman and crew to have the actual coursing laid out before work in the field began

These "Deliverables" helped the contractor improve the following:

- Production
- Supply Chain Management

The contractor's main goal for modeling this project was to get accurate quantities of the burnished CMU.

Once the model and shop drawings were created it was apparent that both could be used to help improve productions and workflows in other ways. The creation of RFIs before being on the project improved the ordering process as well as answering layout questions. Having these questions answered prior to construction had a positive impact on production.

The use of the shop drawings and the model allowed the foreman to have visual confirmation that he was laying out the project the way it was figured by the project management team. This assured that the material quantities would be correct and made the layout easier again saving production time.

This contractor stated that they are moving towards modeling more of their projects because the benefits are easily recognized.

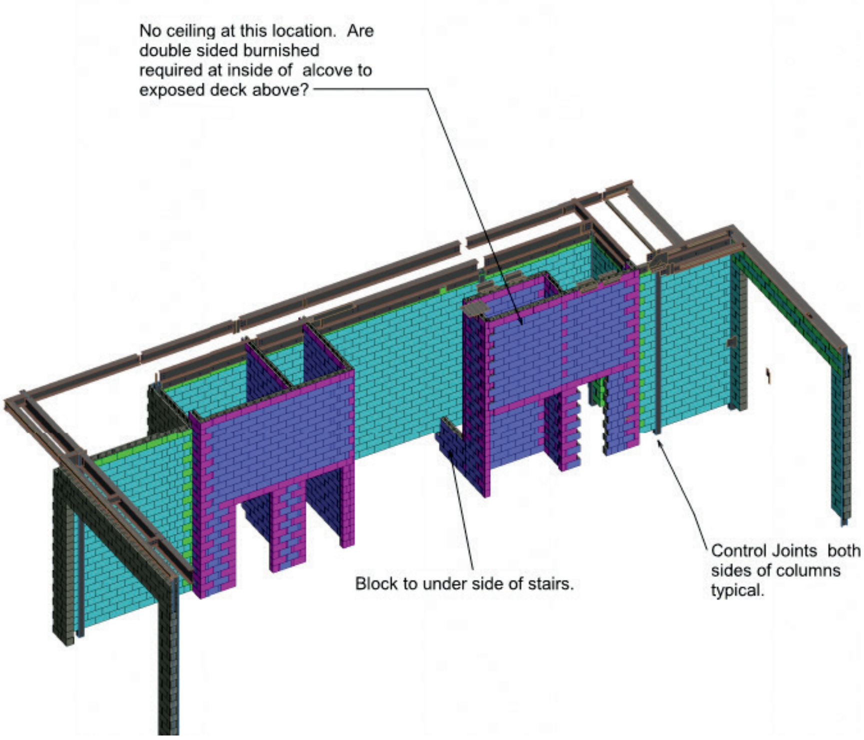


***Figure 6:*** **Washington High School 3D model showing different CMU types and locations generated by Revit model**

# #6
# Case Study

**CASE STUDY #6**

**Project:** Waukesha Memorial Hospital CUP Addition
**Architect:** Eppstein Uhen Associates
**CM/GC:** Findorff Construction
**Mason Contractor:** KMI Construction
**Software:** SketchUp

This project is an addition to Waukesha Memorial Hospital. It consists of 45,000 modular brick, 22,550 regular CMU, and 7,450 acoustical CMU. The structure was cast-in-place concrete structure with CMU backup and brick veneer. Since this is an addition to an existing hospital, the site was very congested and storage space was limited. The contractor created a 3D SketchUp model after the contract was awarded. There was no BIM requirement, BIM coordinator or BIM Execution Plan.

**"Deliverables" Utilized:**

- ***Material Quantities:*** The model was used to lay out the acoustical CMU for approval before ordering. Since there was a substantial amount of grout in these walls, there were special acoustical CMU required at these locations.

- ***Shop Drawings:*** Shop drawings were created for the layout of the acoustical CMU and burnished CMU for approval.

- ***RFIs:*** There were a number of RFIs created on the project concerning layout. The contract documents were created from a Revit model, and many of the dimensions didn't work out for modular masonry units. These layout questions were resolved before mobilizing on the site.

- ***Rebar Placement:*** Rebar shop drawings provided exact information so that the rebar were located in the proper locations and lined up in the CMU cores.

- ***Heights & Coursing:*** Since the contract documents were generated from a Revit model, the coursing was not accurately shown. The SketchUp model created by the contractor illustrated the actual coursing. This was important to show how the concrete structure tied in with the regular and acoustical CMU.

- ***Site Logistics:*** Being able to get quantities from the model for specific areas and walls allowed the contractor to order his material just in time to alleviate congestion on the site and minimize storage and material handling.

The use of the above "Deliverables" generated improvement in the following:

- Production
- Schedule
- Site Logistics
- Supply Chain Management

The site conditions and limited laydown area presented a challenge to all of the trades involved in this project. By modeling the project ahead of time, the contractor was able to coordinate deliveries with placement, which alleviated congestion and minimize any trade stacking.

Creating RFIs before being on the project and having the quantities from the model allowed a continuous workflow without interruption. This was important because the contractor was required to work congruently in multiple areas to maintain the schedule, which they actually improved on.

Creation of the acoustical CMU shop drawing and having it approved by the architect allowed for accurate ordering as well as providing layout, which helped improve production and ensured a smooth workflow without interruption.

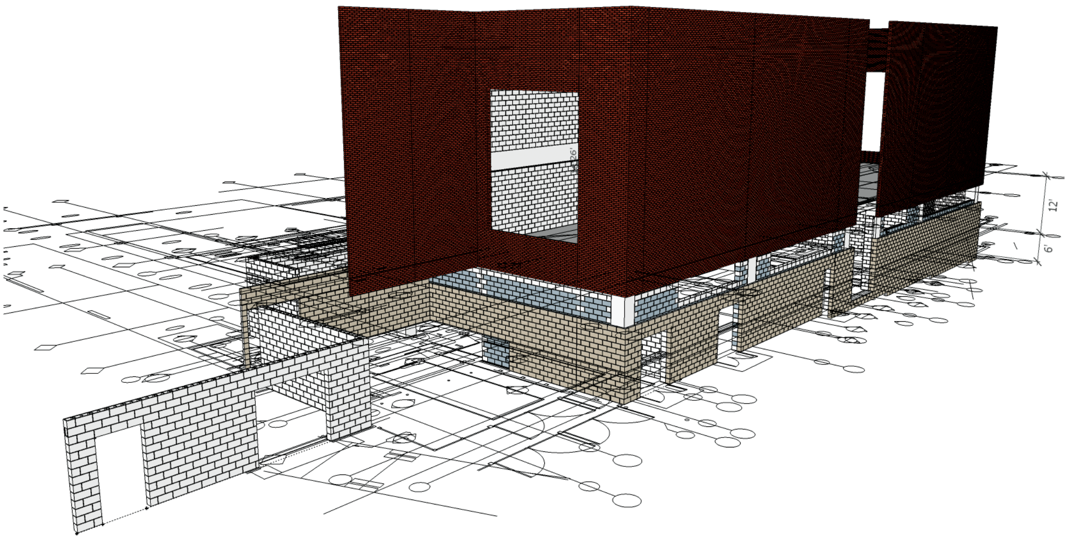

***Figure 7:*** **WMH 3D SketchUp model showing Burnished CMU, Brick and CMU back up shows layout and bond**

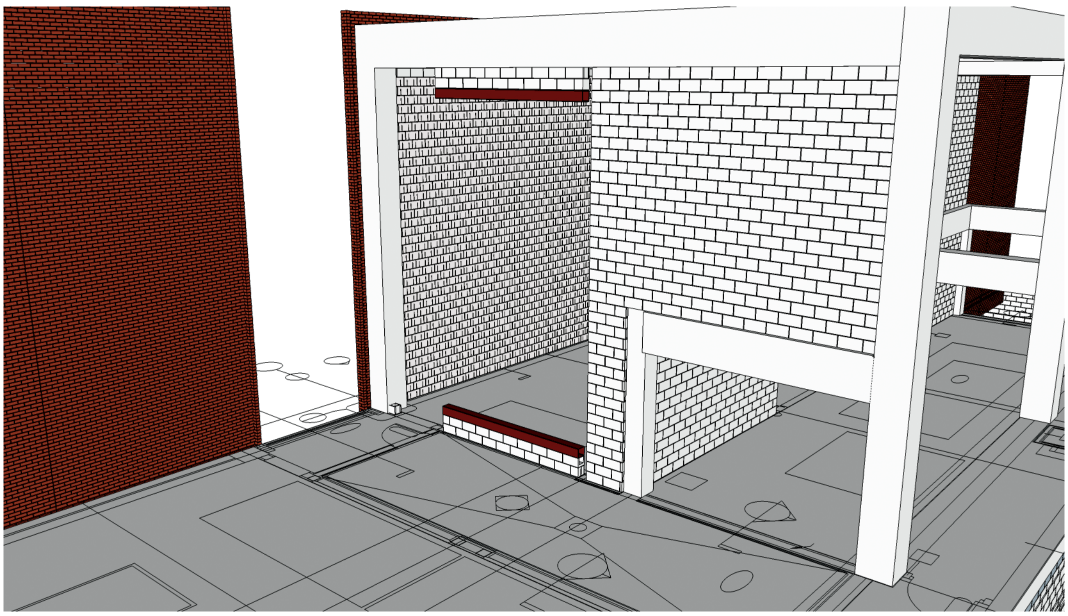

***Figure 8:*** **WMH 3D model showing Acoustic CMU and regular CMU interface with concrete structure showing bond and layout**

# #7
# Case Study

**CASE STUDY #7**

**Project:** St. Augustine School
**Architect:** Korb & Associates
**CM/GC:** VJS Construction Services
**Mason Contractor:** KMI Construction
**Software:** SketchUp

St. Augustine School is a new 180,000 square foot, $40 million school. There are approximately 40,000 CMU on the project, 20,000 of which are burnished. The burnished CMU are three different colors, and there are 24 different shapes. A SketchUp model was created after award of contract and during the startup phase of the project. There was no BIM requirement, BIM coordinator or BIM execution plan for this project.

**"Deliverables" Utilized:**

- ***Material Quantities:*** Material quantities from the model allowed the contractor to create an accurate purchase order. Quantities for specific areas allowed the contractor to streamline deliveries. The CM on the project had "nothing hits the ground policy," which required just in time delivery. Use of the quantities from the model accomplished this.

- ***Shop Drawings:*** The model was used to create the required rebar shop drawings. The contractor created shop drawings detailing the layout for the burnished CMU.

- ***Virtual Mock-ups:*** The model was used to create layout drawings for the mock-ups, which showed required colors and shapes.

- ***RFIs:*** The model was used to generate RFIs during the startup and planning process before the contractor was on site. The RFIs being answered before the crews were on site ensured a smooth workflow on the project and eliminated work stoppages and unnecessary moves by the crew.

- ***Rebar Placement:*** The approved shop drawings were shared with the supplier ensuring that the proper quantities were ordered and delivered to the site. They were shared with the foreman for rebar placement.

- ***Site Logistics:*** This was a very tight site, and the information provided by the model allowed for the scheduling of just in time deliveries, which allowed the maximum utilization of the site for all trades.

Use of these "Deliverables" allowed the contractor to see gains in the following:

- Production
- Schedule
- Site Logistics
- Supply Chain Management

The contractor's main objective was to use the model for supply chain management and site logistic purposes. The project had an accelerated schedule with limited space to store materials. The model allowed for accurate ordering and elimination of waste on-site.

However, once the model was created, the contractor realized the information from the model could be used to help improve other work processes such as production and schedule.

The rebar shop drawings required by the CM and created by the model were also used for rebar placement and layout. Having this information readily available to the foreman sped up the layout process.

Creating CMU shop drawings and virtual mock-ups and being able to incorporate the RFIs into the shop drawings assisted in the on-site layout of the CMU. Having the answers to the RFIs in the modeling process eliminated work stoppages in the construction process. This assured a smoother workflow and helped to improve productivity as well as having a positive impact on the schedule.

The shop drawings and virtual mock-ups were shared with the CM as well as the foreman. This sharing of information allowed for a greater level of cooperation between all of the trades on a very tight site.

The mason contractor states that based on the information obtained from the model and the positive impact to the work processes and workflow, they will continue to model their projects regardless whether it is a contract requirement or not.

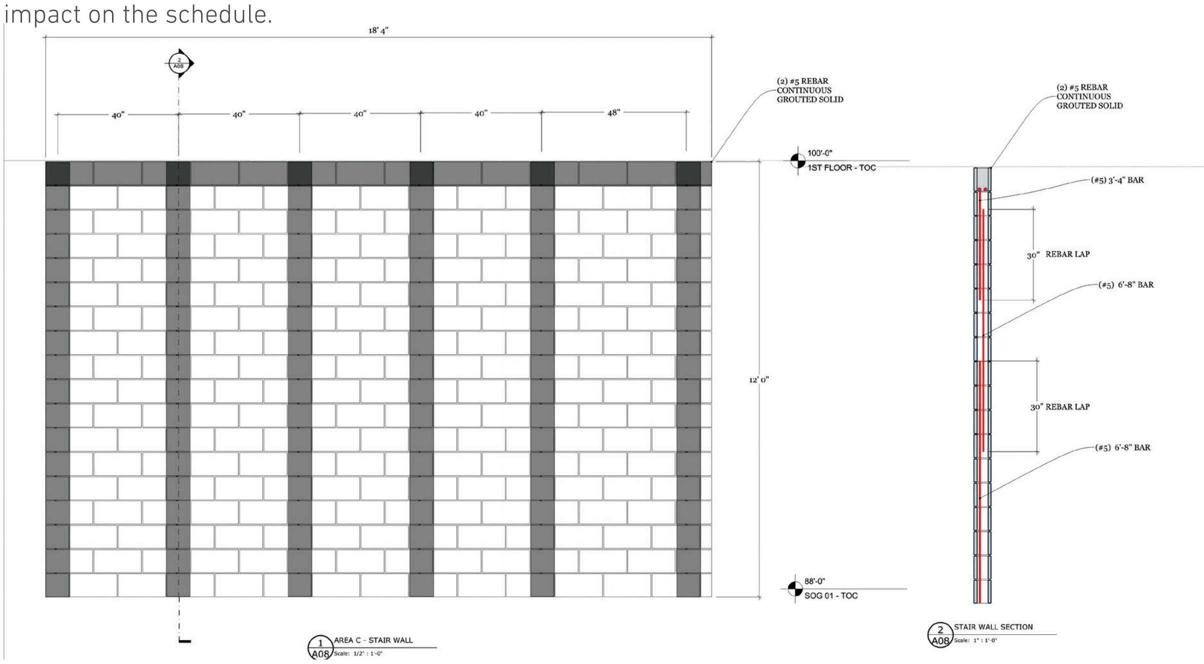


***Figure 9:*** **St. Augustine 2D lift drawing showing grout, rebar and bond beam locations generated from 3D SketchUp model**

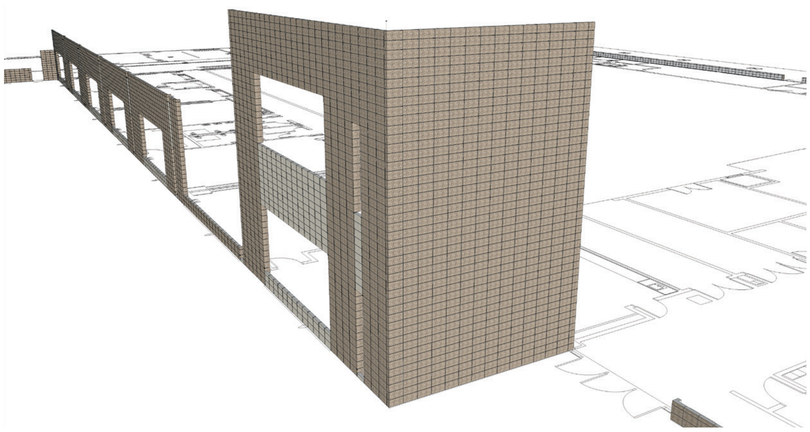

***Figure 10:*** **St. Augustine 3 D model showing Burnished CMU layout and type**

# #8
# Case Study

**CASE STUDY #8**

**Project:** K-12 School Addition
**Architect:** Lindhout Associates Architects
**CM/GC:** O'Neal Construction
**Mason Contractor:** Davenport Masonry Inc.
**Software:** SketchUp

This project was a school addition consisting of split-faced and ground-face CMU. A SketchUp model was created during the startup phase of the project. BIM was not a requirement on this project, there was no BIM coordinator nor was there a BIM Execution Plan. The model was shared with the construction manager and architect.

**"Deliverables" Utilized:**

- ***Material Quantities:*** The model provided accurate quantities of the various CMU types.

- ***RFIs:*** A number of RFIs were created during the modeling process, and were answered before the contractor was on-site. Having the RFIs answered during the preconstruction phase allowed for an uninterrupted workflow during the construction phase, and lent itself to improved production.

- ***Rebar Placement:*** The model was used in the field to aid placement of rebar.

- ***Create Lift/Working Drawings:*** The creation of lift drawings, with RFIs incorporated, simplified the layout process and led to improved productivity.

Use of the "Deliverables" allowed the contractor to see improvements in the following:

- Production
- Schedule
- Supply Chain Management

The contractor stated that the sharing of the information in the model allowed them to improve their workflows and work processes. In light of these improvements, they have stated they will continue to model their projects whether it is a contract requirement or not.

# #9
# Case Study

**CASE STUDY #9**

**Project:** University Classroom, housing and parking
**Architect:** Kohn, Peterson, Fox
**CM/GC:** Walbridge
**Mason Contractor:** Davenport Masonry Inc.
**Software:** Tekla Structures

The contractor was part of the exterior enclosure team on this project. The exterior consisted of a channel-supported terra cotta rain screen wall. A model was created by the mason contractor.

BIM was a contractual requirement and there was a BIM Coordinator for the project. The model was shared with the architect, construction manager and other trades.

**"Deliverables" Utilized:**

- ***Material Quantities***.
- ***Shop Drawings***
- ***Create RFIs***
- ***Heights and Coursing***
- ***Create Lift/Working Drawings***

The use of the "Deliverables" allowed the contractor to reach their goals of improving the following:

- Production
- Schedule
- Site Logistics
- Supply Chain Management

These improvements, as well as being an integral part of the construction team, came from being able to share the information provided by the "Deliverables." Information was shared with the construction manager, architect and all of the enclosure subcontractors. This information sharing allowed the contractor's work to continue uninterrupted, which improved the workflow.

The information the model provided was a great benefit to the on-site foreman. The accuracy of the model allowed the foreman to simplify the installation process, thereby aiding in production and improving upon the schedule.

This contractor said they are quickly becoming believers in the value of modeling their projects.

# #10
# Case Study

**CASE STUDY #10**

**Project:** Froedtert & The Medical College of Wisconsin's Center for Advanced Care
**Architect:** Cannon Design- Architectural and Structural Engineer
**CM/GC:** Mortenson Construction
**Mason Contractor:** Arteaga Masonry
**Software:** Revit

This is an eight story, 608,000 square foot building. Its name reflects the exceptional level of specialty care and medical technologies that are housed there, including the Heart and Vascular Center, Transplant Center, and integrated rooms for surgeries and interventional procedures. The masonry was standard CMU.

Because of the complexity of this project, BIM was a project requirement for the majority of contractors. However it was not a requirement of the mason contractor. Mortenson was the CM, and provided a Revit model of the masonry for coordination and for the mason contractor's use. There was a BIM Execution Plan developed by the CM, architect, and the early trade partners during the design phase of the project. There was a BIM Coordinator to manage the Virtual Design (VDC) scopes of the project.

This project was unique in that the CM and the early-trade partners had unlimited access to the design models, and the designers had access to the construction models. This project was implemented using the "one model" concept early in the design so that the early-trade partners were brought in to finish the construction documents. The MEP coordination was done in conjunction with the completion of the construction documents. This allowed for near fabrication-ready models when construction documents were issued.

**"Deliverables" Utilized:**
- ***Shop Drawings***
- ***Virtual Mock-ups***
- ***RFIs***
- ***Rebar Placement***
- ***Lift/Working Drawings***
- ***Site Logistics***

The CM believes that the more planning done at the task level, the more certainty that can be realized during the construction or installation process. The more information available about what is going in or through the walls the better the coordination. All of the information from the "Deliverables" was shared with the MEP trades as well as the mason contractor to facilitate the installation of all of the wall components whether they were mechanical or structural.

The "Deliverables" as noted helped the contractor to improve the following:
- Production
- Schedule
- Site Logistics
- Supply Chain Management

The CM spends a lot of time planning the construction work down to the task level. The masonry placement drawings are a major factor in planning that scope of work. They believe better plans lead to improving all of the items listed above. The focus in this particular project was on the site logistics and schedule.

On a project of this size, the construction manager needs to understand who will be where and for how long. Those durations can then be communicated to all of the affected trades. The lift drawings allowed for zero rework on the masonry wall installation leading to better quality.

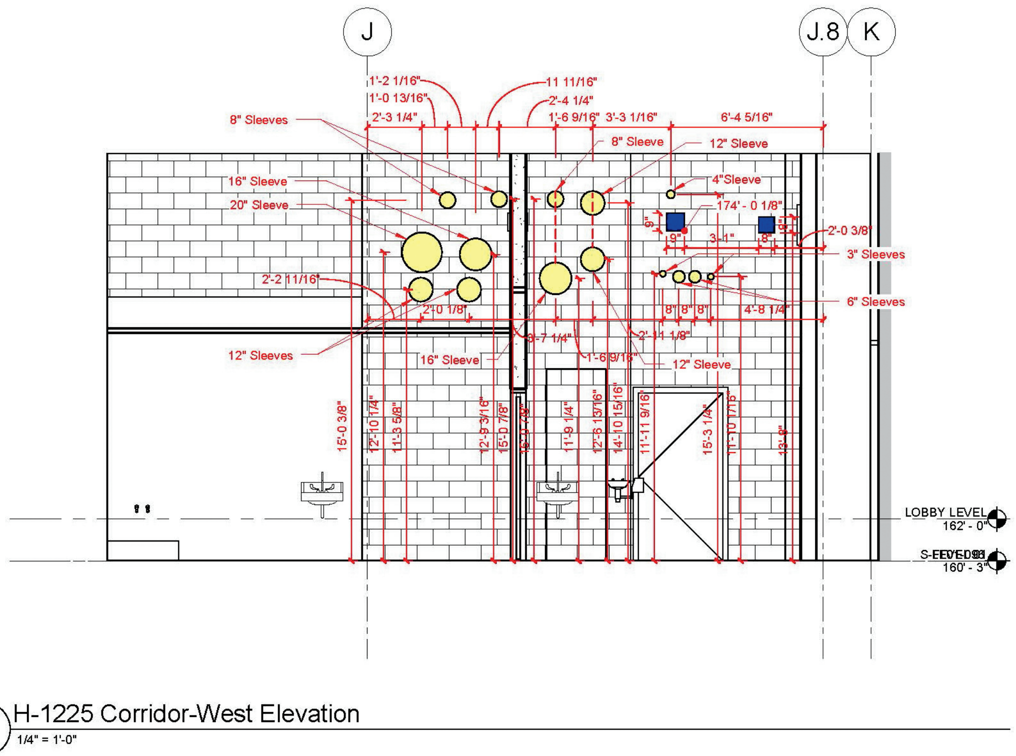


*Figure 11:* **Center for Advanced Care 2D lift drawing generated by Revit model showing layout and wall penetrations**

# #11
# Case Study

**CASE STUDY #11**

**Project:** St. Camillus CBRF & Jesuit Housing
**Architect:** Plunkett Raysich Architects
**Engineer:** KJWW
**CM/GC:** Mortenson Construction
**Mason Contractor:** JP Cullen
**Software:** Revit

This project was a sizable addition to the already existing St. Camillus Home. The CM started with the Revit design model and added additional detail as required for construction. This model was shared with J.P. Cullen, the mason contractor, to use as a starting point for the masonry model.

BIM was a project requirement for the majority of the contractors including J.P. Cullen. The CM and the mason contractor both had a BIM coordinator for the project.

A BIM Execution Plan was drafted and implemented by the CM for the project.

**"Deliverables" Utilized:**

- ***Shop Drawings***
- ***Virtual Mock-ups***
- ***RFIs***
- ***Rebar Placement***
- ***Heights and Coursing***
- ***Lift/Working Drawings***
- ***Site Logistics***
- ***Prefabrication***

Positive Outcomes realized by the above "Deliverables":

The project set out to shave time off the schedule wherever possible, and the implementation of LEAN tactics during the construction process. The innovative use of prefabricated walls by the mason contractor achieved both of these goals.

Prefabricated masonry modules were constructed in a warehouse off-site. Each module was eight feet tall. Elevator modules had four sides, while stair modules had three sides. All of the modules incorporated the required reinforcing and bracing components. The modules were constructed based on the information and details from the Revit model created by the mason contractor.

The initial four to six courses at the base of the wall were laid on-site to account for any irregularities in the footings or foundation. When this was complete, the modules were set using a crane.

The erection time for both 40-foot shafts and ten modules was two days. The prefabrication of the masonry saved 10 to 13 days of on-site erection time. The model and the information that it provided allowed for this prefabrication.

The prefabrication greatly reduced any on-site safety hazards. There was no on-site scaffold required, therefore reducing potential on-site hazards. The modules being constructed in a controlled environment also greatly reduces exposure to any hazards.

The erection of the modules only took two days and the absence of scaffolding allowed other trades to work unobstructed in this and surrounding areas. This lack of jobsite congestion had a positive impact on schedule and safety.

The mason contractor's innovative use of prefabrication and the information from their Revit model proved to be a benefit to the whole project.

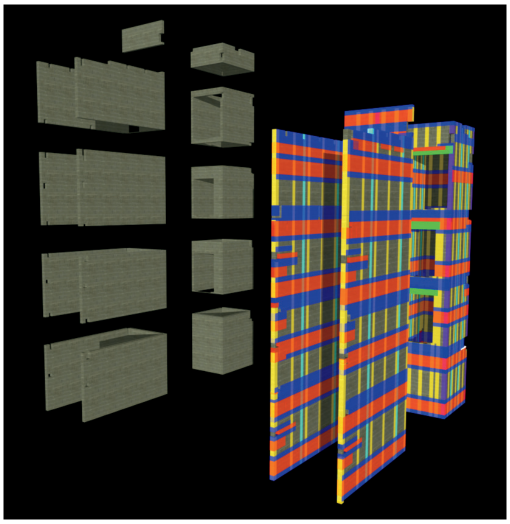

*Figure 12:* **St. Camillus 3D model showing grout, rebar and bond beams generated by Revit model**

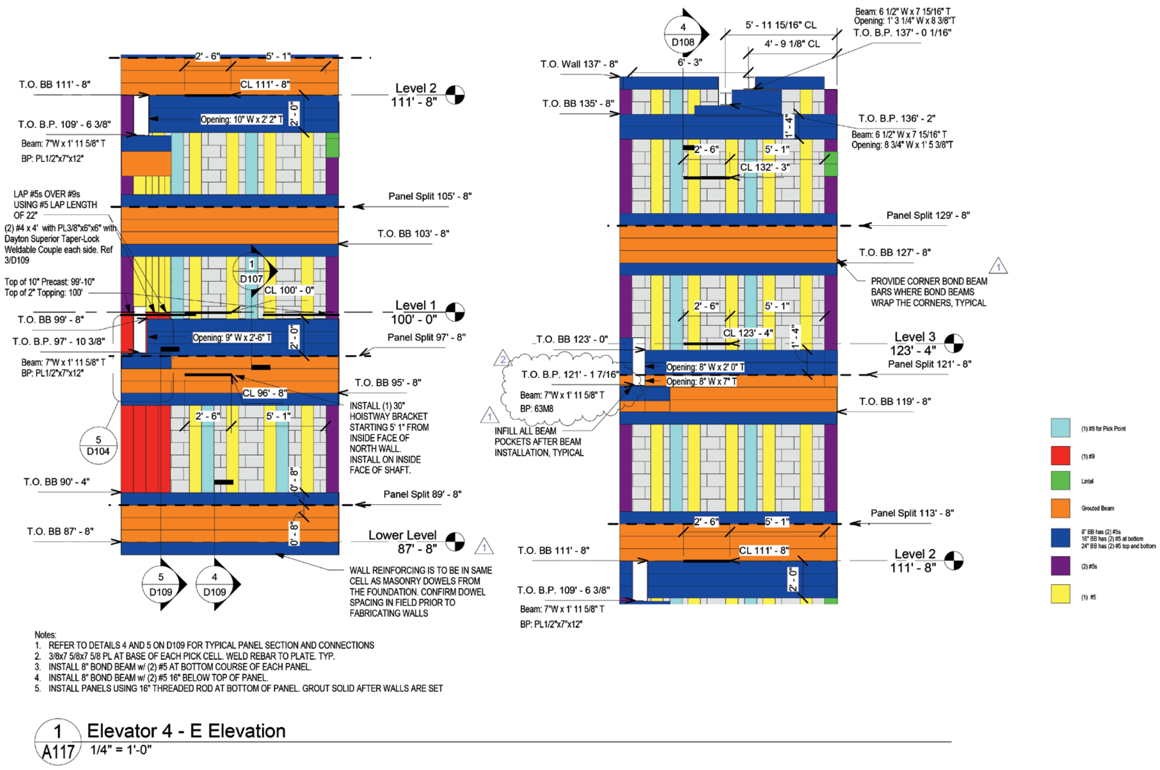


*Figure 13:* **St. Camillus 2D lift drawings generated by Revit model showing grout, rebar and bond beams**

# #12
# Case Study

**CASE STUDY #12**

**Project:** Fulton Mental Health Facility
**Architect:** Parsons Brinkerhoff, Heery International, David Mason & Assoc.
**CM/GC:** River City Construction
**Mason Contractor:** John J Smith Masonry Co
**Software:** AutoCad

This project is a 723,363 square-foot mental health hospital consisting of a four-inch veneer over CMU backup with CMU partition walls. The model of the masonry was created by CADBlox, a masonry modeling service. There was no BIM requirement, but there was a BIM coordinator and BIM Execution Plan. Even though it was not a requirement, the mason contractor had CAD BLOX participate in the BIM coordination meetings. The model was loaded into Navisworks for clash detection. Participation in the coordination process by the mason contractor and CAD BLOX proved beneficial to the whole construction team. The model was shared with the architect and engineer, structural steel contractor and mechanical trades, the construction manager as well as the mason foreman.

**"Deliverables" Utilized:**

- ***Material Quantities***
- ***Shop Drawings***
- ***RFIs***
- ***Heights and Coursing***
- ***Create Lift/Working Drawings***

The use of the above "Deliverables" allowed the contractor to see improvements in the following:

- Production
- Supply Chain Management
- Clash Detection

By using the model, the contractor was able to have very accurate quantities for improved material ordering. Coordination between the steel and masonry models allowed for embeds, beam pockets and beam pass-throughs to be accurately placed. Shop drawings generated by the model made coordination between the field and project management seamless and allowed for very precise layout of the CMU saving production time.

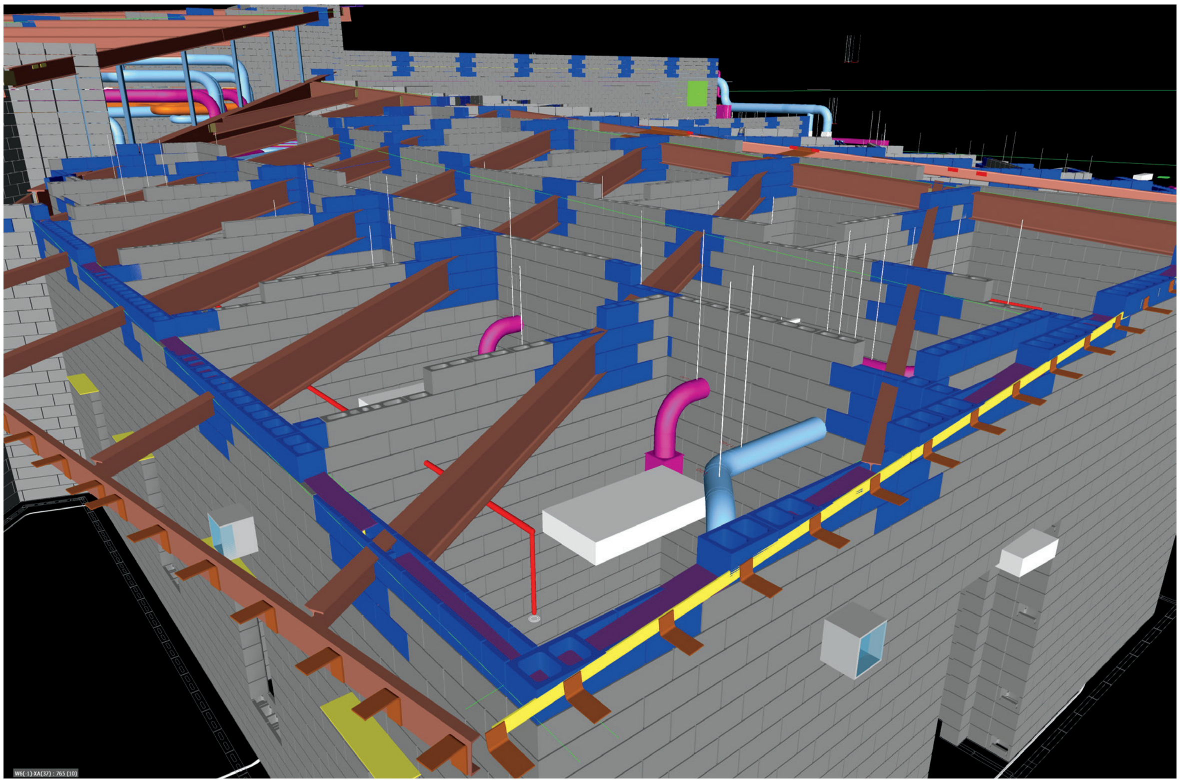

*Figure 14:* **Fulton Mental Health 3D Model showing CMU and Steel interaction generated by CAD BLOX**

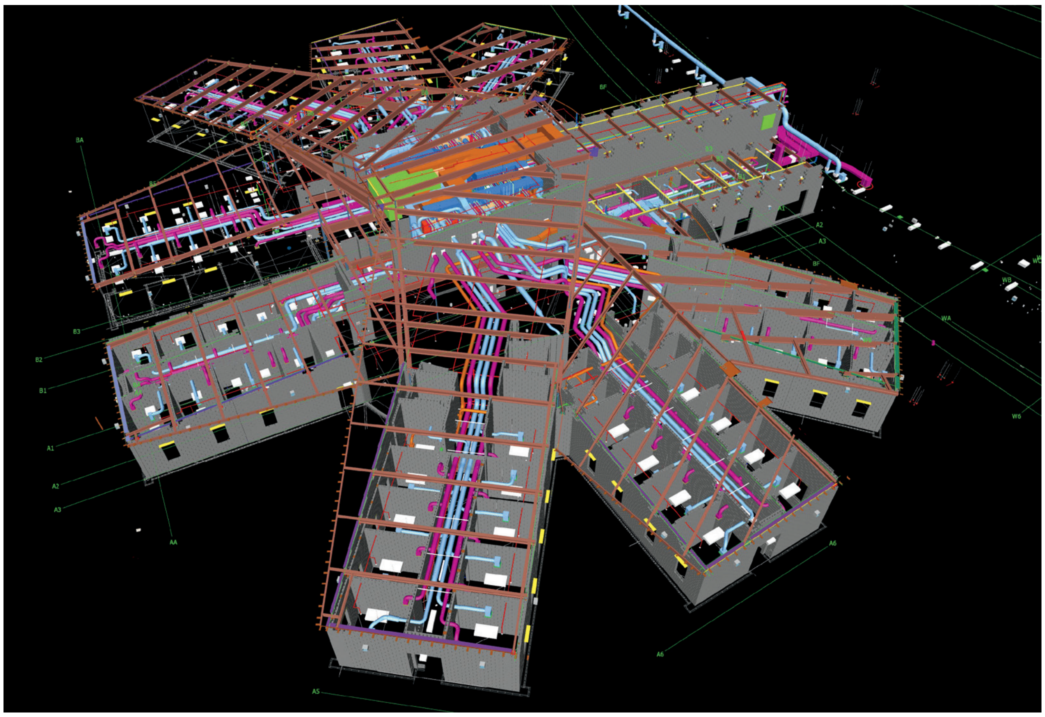

*Figure 15:* **Fulton Mental Health Clash Detection all wings by Navisworks**

# Conclusions

The goal of Volume II of the *BIM Deliverables Guide for Masonry Contractors* is to highlight a number of project case studies where the masonry was modeled using various software systems currently being used by contractors in the BIM environment. The emphasis of the case studies is the "Deliverables" that are available through modeling, and how the use of those "Deliverables" improved the workflows and work processes for each project highlighted by the case studies.

Some of the "Deliverables" that were available through modeling were material take-off, shop drawings, virtual mock-ups, RFI creation, rebar placement, establishing heights and coursing, creation of 2D lift and working drawings, equipment and scaffold requirements, site logistics and clash detection.

The use of the "Deliverables" led to improvements in production, material supply chain management and scheduling and site logistics.

Improvements varied based on the number of the "Deliverables" utilized, as not all of the "Deliverables" were used on every project. However, all of the improvements were substantial enough that all of the contractors stated it was their intention to continue to model the masonry on their projects, whether it was a contract requirement or not.

Case study participants had varying levels of participation in the whole BIM process. BIM was a project requirement for three of the projects, three of the projects had a BIM coordinator and two of the projects had a BIM Execution Plan. Six of the contractors shared either the model or information from the model such as shop drawings with various members of the construction team, including the architect/engineer, construction manager/general contractor, foreman/field staff, and material suppliers. In most cases the information from the models was used exclusively by the mason contractor in an effort to improve their workflows and processes.

Based on the information in the case studies, the first deliverable utilized in most cases was quantity take-off. This information was readily available from the model. Accurate material take-off ensured that the quantities ordered were correct, which ensured smooth workflows, and helped eliminate over-ordering reducing waste. This added accuracy also avoided costly delays and additional setup costs if an order was short. Just by using this one deliverable, mason contractors can realize improvements in supply chain as well as schedule.

Once engaged with the modeling process, it didn't take the contractors long to realize how to make use of the other "Deliverables." When you create a model, you are virtually building the building. Much of the information from the "Deliverables" is readily available, or the lack of information on the drawings stimulates questions such as RFIs.

Here is one example of how the process might evolve;

- A contractor wants to get an accurate material take-off from the model. In order to get an accurate take-off, the project is modeled, which is building it virtually before you build it
- Building it virtually creates the building layout, which includes the heights and coursing.
- If there are discrepancies in the layout, the contractor creates RFIs to correct the layout.
- Once the layout is correct and complete, the contractor can create 2D lift drawings, working drawings, and shop drawings.
- These drawings can then be shared with the foreman and crew. Having this information before the crew is on site allows for smoother workflow, improved production and schedule. If the mason contractor sees improvements in schedule and production, this will ultimately impact the project as a whole.
- The CM/GC, and other trades, will be positively impacted by the modeling done by the mason contractor. This will ultimately have a positive effect on masonry's market share.

The case studies presented illustrate why mason contractors should model their projects, whether it is a contract requirement or not. The case studies offer tangible documentation of how modeling can improve productivity, schedule, site logistics and supply chain management. All of these improvements lead to reduced costs for the mason contractor.

The examples of the information exchanges between the mason contractors, material suppliers, A/E, CM/GC and other trades show that masonry is a viable material in the BIM environment now and into the future. These information exchanges also illustrate how mason contractors are prepared to move into the new technologies of the 21st century.

The BIM-M Initiative continues to move forward by developing new tools that makes it easier for contractors and designers to work with masonry in the BIM environment. The latest releases include *BIM for Masonry, Modeling Buildings in Autodesk Revit, Masonry Pack- Revit Wall Content Library, and the BIM Deliverables Guide for Masonry Contractors*. These are all available for free download at bimformasonry.org. Make sure to view the instructional videos available on the BIM-M YouTube channel.

There are a number of projects under development that will be released in the near future. The Masonry Unit Data Base (MUD) is a database that will be web-based. The first version will include generic brick units and CMU. The second will address custom brick, CMU, stone, and tile. The third will include manufacturer's specific units. This tool will make it easier for designers to use masonry in their Revit models. This database will be available to contractors. Through the use of plug-ins, it will work with SketchUp and Tekla, making it much easier for contractors to get started in the modeling process.

The Wall Systems Library (WSL) being developed by International Masonry Institute (IMI) for BIM-M using SketchUp, and its companion LayOut, is due for release in 2017. The WSL will classify name and number, and will graphically define numerous masonry walls in a simple format based on the taxonomy of seven wall sub-assemblies. The resulting database of masonry walls eventually may be converted to Revit and other platforms standardizing the way the masonry industry classifies masonry walls. This type of uniformity will benefit contractors, architects and engineers since it will present design and construction options in a systematic way.

These new materials, as well as *BIM Deliverables Guide for Masonry Contractors Volume II* will all be available at bimformasonry.org. Please make sure to regularly check the website and YouTube channel for these tools and future instructional videos.

# Acknowledgments

BIM-M is grateful to all those who supplied the case study information and their willingness to share it with the industry. This unselfishness indicates the desire of these firms to better the masonry industry and improve the business of masonry through digital technology.

**Mike Madone** Mountain Masonry LLC
**Austin Norberg** and **Justin Wenger** Seedorf Masonry
**Mike Kinateder** KMI Construction

**Ed Davenport** Davenport Masonry

**Shaun Hester** and **Kevin Kendellen** Mortenson Construction
**Cameron Weinbrenner** JP Cullen

**John Smith** John J Smith Masonry

# Appendix:
# Case Study Comparison

| Project | CASE STUDY #1 Manufacturing Facility | CASE STUDY #2 S.E. Health Group Expansion | CASE STUDY #3 Occhiato University, CSU | CASE STUDY #4 Washington H.S. Washington, IA |
|---|---|---|---|---|
| Mason Contractor | Davenport Masonry | Mountain Masonry | Mountain Masonry | Seedorf |
| Software | SketchUp | Revit | Revit | Revit |
| Project Requirement | No | No | No | No |
| BIM Coordinator | No | No | No | No |
| BIM Execution Plan | No | No | No | No |
| Plan Developer | | | | |
| Model Shared | No | Yes | Yes | No |
| **Improvements:** | | | | |
| Production | Yes | Yes | Yes | Yes |
| Schedule | Yes | Yes | Yes | |
| Site Logistics | No | Yes | Yes | |
| Supply Chain | No | Yes | Yes | Yes |
| Any Other Goals | | | | |
| **"Deliverables":** | | | | |
| Material Quantities | Yes | Yes, used for bidding | Yes | Yes |
| Shop Drawings | Yes | Yes | Yes | Yes |
| Virtual Mock-ups | No | | Yes | |
| RFIs | No | Yes | Yes | Yes |
| Rebar Placement | Yes | Yes | n/a | |
| Heights & Coursing | No | Yes | Yes | Yes |
| Lift/Working Drawings | Yes | Yes | Yes | Yes used in field |
| Equipment Scaffold | No | Yes | Yes | |
| Site Logistics | No | | | |
| Other | | | | |
| **Information Exchange:** | | | | |
| Foreman | Yes | Yes | Yes | |
| Material Suppliers | Yes | Yes | Yes | |
| A/E | No | Yes | Yes | |
| GM/GC | No | Yes | Yes | |
| Other Trades | No | Yes | Yes | |
| Improve Workflows/Process | Yes | Yes | Yes | Narrative |
| Continue Modeling | Yes | Yes during bidding | Yes | See Narrative |

# Appendix:
# Case Study Comparison

| Project | CASE STUDY #5<br>Fire Station<br>Davenport, IA | CASE STUDY #6<br>Waukesha Memorial Hospital Addition | CASE STUDY #7<br>St. Augustine School | CASE STUDY #8<br>K-12 School Addition |
|---|---|---|---|---|
| Mason Contractor | Seedorf | KMI Construction | KMI Construction | Davenport Masonry |
| Software | Revit | SketchUp | SketchUp | SketchUp |
| Project Requirement | No | No | No | No |
| BIM Coordinator | No | No | No | No |
| BIM Execution Plan | No | No | No | No |
| Plan Developer | | | | |
| Model Shared | No | Shop drawings shared | Shop drawings & RFIs | Yes |
| **Improvements:** | | | | |
| Production | Yes | Yes | Yes | Yes |
| Schedule | | Yes | Yes | Yes |
| Site Logistics | | Yes | Yes | No |
| Supply Chain | Yes | Yes | Yes | Yes |
| Any Other Goals | | | | |
| **"Deliverables":** | | | | |
| Material Quantities | Yes | Yes | Yes | Yes |
| Shop Drawings | Yes | Yes | Yes | No |
| Virtual Mock-ups | | | Yes | No |
| RFIs | Yes | Yes | Yes | Yes |
| Rebar Placement | | Yes | Yes | Yes |
| Heights & Coursing | Yes | Yes | | No |
| Lift/Working Drawings | | | | Yes |
| Equipment Scaffold | | | | No |
| Site Logistics | | Yes | Yes | No |
| Other | | | | |
| **Information Exchange:** | | | | |
| Foreman | | Yes | Yes | Yes |
| Material Suppliers | | Yes | Yes | |
| A/E | | Yes | Yes | Yes |
| GM/GC | | Yes | Yes | Yes |
| Other Trades | | No | | |
| Improve Workflows/Process | Narrative | Yes | Yes | Yes |
| Continue Modeling | | Yes | Yes | Yes |

# Appendix:
# Case Study Comparison

| Project | CASE STUDY #9 University Classroom Addition | CASE STUDY #10 Frodert Hospital Center | CASE STUDY #11 St. Camillus CBRF & Jesuit Housing | CASE STUDY #12 Mental Health Hospital |
|---|---|---|---|---|
| Mason Contractor | Davenport Masonry | Artega Construction | J.P. Cullen | John J Smith Masonry |
| Software | Tekla 3D Structures | Revit | Revit | CAD Blox |
| Project Requirement | Yes | Yes | Yes | No |
| BIM Coordinator | Yes | Yes | Yes | No |
| BIM Execution Plan | No | Yes, drafted by CM/Architect | Yes | No |
| Plan Developer | | Mortenson & Cannon | CM Mortenson | |
| Model Shared | Yes | Yes, Federated model | Yes, between Mortenson/Cullen | Yes |
| **Improvements:** | | | | |
| Production | Yes | Yes | Yes | Yes |
| Schedule | Yes | Yes | Yes, through prefabrication | |
| Site Logistics | Yes | Yes | Yes | |
| Supply Chain | Yes | Yes | Yes | Yes initiated by manufacturer |
| Any Other Goals | | | Lean tactics | |
| **"Deliverables":** | | | | |
| Material Quantities | Yes | | | Yes |
| Shop Drawings | Yes | Yes | Yes | Yes |
| Virtual Mock-ups | No | Yes | Yes | No |
| RFIs | Yes | Yes | Yes | Yes |
| Rebar Placement | No | Yes | Yes | Yes |
| Heights & Coursing | Yes | | Yes | Yes |
| Lift/Working Drawings | Yes | Yes | Yes | No |
| Equipment Scaffold | No | | | Yes |
| Site Logistics | No | Yes | Yes | |
| Other | | | Prefabrication | |
| **Information Exchange:** | | | | |
| Foreman | Yes | Yes | Yes | Yes |
| Material Suppliers | Yes | | | Yes |
| A/E | Yes | Yes | Yes | Yes |
| GM/GC | Yes | Yes, created model | Yes | Yes |
| Other Trades | Yes | Mechanicals | Yes | Yes |
| Improve Workflows/Process | Yes | Yes | Yes | |
| Continue Modeling | Yes | Yes, CM will continue modeling | Yes | |

# Notes

# BIM-M

## Building Information Modeling for Masonry

## Executive Committee:

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National Concrete Masonry Association FOUNDATION

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team UNION MASONRY CRAFTWORKERS CONTRACTORS & CONSULTANTS

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New York State Structural Masonry Coalition
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