AUTODESK UNIVERSITY

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Dewey Modelit and Howe: BIM for Existing Structures

Kate Morrical Towne
Silman

Learning Objectives

- Learn how to identify potential pitfalls when modeling existing buildings
- Get tips for model management of uncertainty in existing conditions
- Learn about best practices for modeling demolition of existing elements
- Discover the pros and cons of reality capture for structural elements

Description

Capitalizing on Building Information Modeling (BIM) for new buildings is easy—you get to start with a fresh, clean file, and you can lay out everything you need precisely where it's supposed to be. But what if you're doing an addition, a renovation, or a historic preservation? Maybe you have existing drawings. (Maybe they're accurate!) Maybe you have some reality capture data. But most of what is important to a structural engineer is probably hidden behind an existing facade or finish. And yet the model must go on. Join this session to see how one firm has dealt with the challenges of managing uncertainty and balancing precision with usability in models of existing buildings.

About the Speaker

Silman is a structural engineering firm with offices in New York, Boston, Washington, DC, and Ann Arbor. As the Digital Design Manager, Kate is responsible for coordinating procedures and standards for software used in the design process, whether CAD, BIM, or design/analysis programs. Before rejoining Silman in 2012 (where she also worked from 2003 to 2008), Kate was a Technical Marketing Manager for Autodesk, Inc. There, she worked on the AutoCAD software family of products, specifically AutoCAD LT software. She has over 15 years' experience with Autodesk products, served on AUGI's Board of Directors from 2013 to 2018 (including as President 2017-2018), and has presented at numerous technical events, including Revit DC, BILT North America, Midwest University, and several Autodesk University conferences.

Introduction

Every BIM project has its own set of challenges. This is especially true for work on existing structures. Some of the concerns particular to renovation, restoration, and remodeling include:

- Successful BIM kickoff meetings and project setup
- Acquiring information about the existing building
- Strategic modeling for existing elements
- Using phases to manage a project lifecycle

First up are strategies for making sure your projects start off on the right foot. Then it's about acquiring information about the existing building, whether from paper drawings, CAD files, or laser scans. Once that's settled, it's time to model. But what *can* you model, and what *should* you model? Finally, we'll talk about phases, and using them—or not—to make sense of your project's lifecycle.

Starting Off Right

Every building project, whether new or existing, should start with a clear vision. And it's important for everyone on the team to have the *same* vision.

Which brings us to the first question…

Does it have to be BIM?

It sounds heretical, but not every building project has to be 3D. If the scope is small enough (adding a single beam) or flat enough (crack repair on a wall), maybe 2D drawings—or even images!—are enough to convey the necessary information.

Once the team has agreed that yes, this project should use BIM, it's time for a kickoff meeting. It doesn't matter how small your project is. This meeting *must* happen. Depending on the size of the project, it could be an informal conversation or a highly structured conversation. At a minimum, it should involve the BIM Lead and the Project Manager from each firm. (Sometimes, those two roles might be the same person.) This way, you have people who can cover design and technical issues, and you can look at each item from multiple perspectives.

At the BIM kickoff meeting, you'll want to go over the BIM Execution Plan (often abbreviated BEP or BxP) or Project Execution Plan (PEP or PxP). If you're a sub-consultant, you're usually lucky—the architect has probably taken the lead on creating this document. If they haven't, you can, and you should. There are many resources available for creating BEPs, and an excellent place to start is Penn State's BIM Planning website (http://bim.psu.edu). They have all kinds of articles and downloads to help you develop your own BEP.

The details of all sections of a BEP are beyond the scope of this handout, but we will cover those that are relevant to BIM for Existing Buildings (hereby known as eBIM).

Key Sections of an eBIM Execution Plan

There are no answers in the sections below, only questions. Try to get answers from the design team, the contractor, and the client.

Goals & uses

Why are you modeling the existing building? What will it be used for? Who benefits?

Deliverables

Do the contract requirements include the model, or is it only 2D drawings?

Existing Documentation

What existing documents are available? Are they complete? Are they reliable? What format are they in?

Scope of Work

What exactly is being done to the building—is it a complete gut & renovation, a seismic retrofit, or just an opening for a new elevator? Understanding the extents of the project helps the BIM team focus their efforts in the best place.

Scope of Model

How much of the existing building is the team going to model? How will you handle elements that are outside the scope of work?

Model Element Authoring & Sharing

Who will be modeling what, and what will it look like? Equally importantly, what dependencies exist between modeled elements? For example, if the structural team will be modeling the wall core, but the architect will be modeling the existing finishes, how will you coordinate those efforts? A Model Element Matrix may help you outline this work—links keep changing, but your favorite search engine can help you find current samples.

Sidebar: Level of *What*?

The Model Element Matrix you find online will probably have a column for “Level of Development”. You’ve probably heard of this (if not, head back to Google), and it’s a useful concept in BIM when applied to *new buildings*. Please resist the urge to use it for existing elements! Here’s why.

Level of Development (LOD) is a scale ranging from 100 to 500, where higher numbers indicate more information available about the final design. Therefore, by definition, an existing element is fully developed! Yet it’s likely that you don’t have all the information necessary to actually model an LOD 500 element. (You probably don’t have a business case for LOD 500 either.) So, you need a different scale.

If you really want to keep saying “LOD” for your existing elements, consider repurposing it as “level of detail.” That version is usually inappropriate for new buildings (an element can be highly detailed even if its design isn’t finished), but for existing buildings it could indicate the level of approximation or generic-ness of the modeled element.

Level of Accuracy (LOA) is intended to measure how close a modeled element aligns with its real-world counterpart. That's more like it! LOA can range from 10 to 50, and higher numbers indicate a more precise match. But sometimes even this doesn't quite capture everything.

Level of Confidence (LOC) is a framework developed by Silman to indicate how much is *known* about the element being modeled. Too often, structural engineers have to model things that can't be seen: joists in a floor, columns inside drywall, etc. LOC, a scale ranging from 0 to 2 (usually), provides a way to track what's known—or unknown—about the elements hidden from view, but which are present in a Revit model anyway. (See "Level of Confidence" for more information.)

What's Out There?

Once you've got the essentials of the modeling process down, how do you find out exactly what to model? It's one thing for a new building, where you don't have anything old to worry about. For an existing structure, you probably don't have an as-built, well-maintained, 3D, interactive model. (Won't it be nice when all buildings have those?) Instead, you have to work with what you've got. And when it comes to existing buildings, sometimes that's not a lot.

As important as the structure and infrastructure of a building is, it often gets covered up by architectural elements. And fine, it usually looks better that way! But the result is that essential elements for structural and MEP models aren't available for easy evaluation and measuring. This isn't just a BIM problem, by the way. Even working in 2D, it's important to know the details of a building's construction. So, how do you get it?

Existing Documentation

If you're lucky, you have the original building drawings.

If you're really lucky, they look like this:

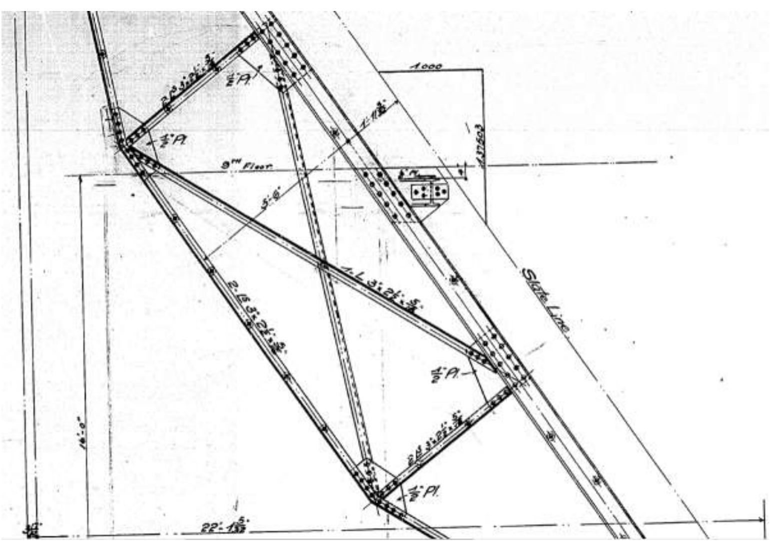


Figure 1: A clear, legible existing drawing

If you're not, they look like this:

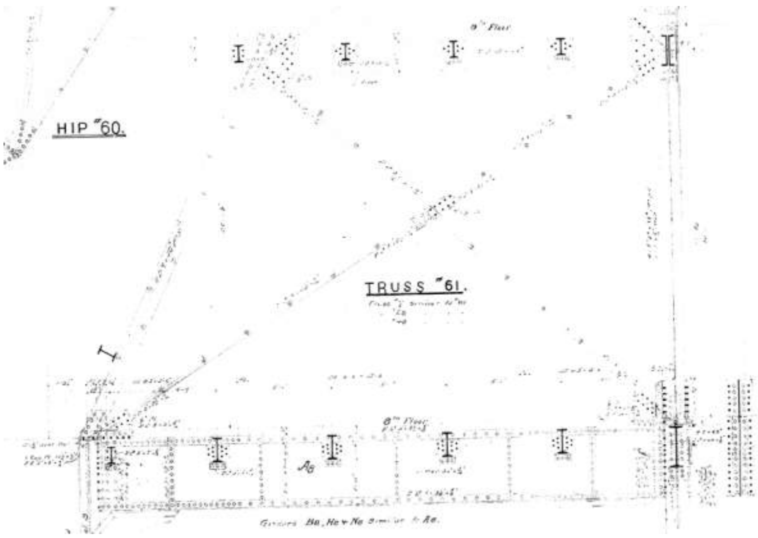


Figure 2: A more common existing drawing

In that case, all the documentation in the world isn't much help.

Even if you have legible drawings, you should always "trust but verify." There's a reason post-construction documents are called "as-built," not "as-designed." So, you head out to the field to do your verification…and you still can't see what you need. (Because the architects covered it up.) Maybe you'll have a bit of exposed structure or ductwork…maybe you're allowed to do a few probes. Most of the time, you have to interpolate and extrapolate based on what little you can see. There'll be more on how to deal with the reliability of this information a little later.

Non-Destructive Evaluation

Another way to investigate a building is with non-destructive evaluation (NDE) such as X-rays or ground-penetrating radar (GPR). These methods can be extremely useful in some situations, but not all. Structural engineers use GPR most often for locating rebar in concrete, or voids within walls or floors. This can be essential information for evaluating the capacity of an existing structure, but it's not as helpful for creating construction documents. It can certainly be integrated into a BIM process, but it's not a panacea.

Laser Scanning & Photogrammetry

As far as existing structures are concerned, photogrammetry can make pretty pictures, but it doesn't yet have the precision required for most structural elements. If all you need is the overall shape of something, or if you're trying to create 2D rectified images (as of a façade), it's a good tool. But if you need 3D measurements with a reasonable degree of precision, you'll probably want a laser scan.

For as much hype as laser scanning gets, it is also not a silver bullet. First, they have the same problem as visual surveys: if you can't see it, you can't scan it! There are other logistical concerns as well, like tying together (registering) scans done in different areas or getting access to extremely tight spaces. The benefits, of course, are the accuracy that come with laser measurements, and the ability to get data from literally unreachable places.

Tips for Laser Scanning

In order to get those good results, here are some tips & topics to include in your pre-project conversations.

Get involved early. Subconsultants are too often presented with a finished point cloud. This means that it was done with the input and perspective of only one discipline. By not including all team members from the beginning, you miss out on opportunities to accommodate other uses. This is especially critical if a Revit model is part of the deliverable package (see below).

Confirm site access. Can you get access to what you need? Are there multiple places to locate a scanner to minimize shadowing? How much space do you have to work in? Confined spaces present a challenge to laser scans, from getting the equipment in the space at all to minimizing shadows and registering scans together to form one overall model. Is there anything else in your way, like scaffolding, temporary structure, or even people? If so, how will you work around it? The laser scan will pick up scaffolding just like it picks up real building elements.

Define any color or photo needs. Scanning in black-and-white is much cheaper than scanning in color. Black-and-white is also not dependent on ambient lighting. Sometimes, though, color really is better. It'll be up to the team to make that call.

Specify required accuracy/density/resolution. Accuracy of laser scanners is generally very high. Any errors tend to be introduced during registration, when linking of individual scans together. Specifying a tolerance for individual and overall registration errors is generally a good idea. Density is considered to be the distance between points in a cloud, and it depends on the resolution of the scanner and the distance from the scanner to the target. It's most efficient to scan to the *lowest* acceptable density—higher densities don't always add much more information, and they can increase the time & cost of the scanning project.

Clarify post-processing and deliverables. Will any cleanup be done to remove extraneous points? (See above on scaffolding.) If a Revit model is a deliverable, who's creating it? Will they use shape extraction? Who will be creating the Revit model from the point cloud? If it's not you, you *must* be specific in communicating your needs, especially discipline-specific requirements. Any families, processes, or other standards have to be set out at the beginning, or your odds of receiving them drop dramatically. Be extra careful if you need atypical elements, such as analytical shell elements with corners that are interpolated between the interior and exterior points of a wall, floor, or roof. Otherwise, you may get elements that aren't as functional for your purposes.

Scan-to-BIM Deliverable Language

Perfectly aligning a Revit model with a point cloud isn't only next to impossible, it's often counterproductive. (Who wants to try to dimension walls at 89.73°?) Instead, consider the following concept:

Elements should be modeled orthogonally wherever the design intent was an orthogonal layout. If this is in conflict with the Represented Accuracy tolerance, orthogonal modeling is still preferred. Usability of the Revit model is prioritized over hyper-accuracy.

This approach will still require some compromises, especially for elements with large out-of-plane variations, but your Revit users will be happier. And it opens the door to another kind of application of laser scanning: model comparison.

With tools like ClearEdge3D's Verity™, solid models can be compared against point clouds and the variations displayed and calculated. (They built it for new projects & construction scans, but it'll work for existing buildings too!)

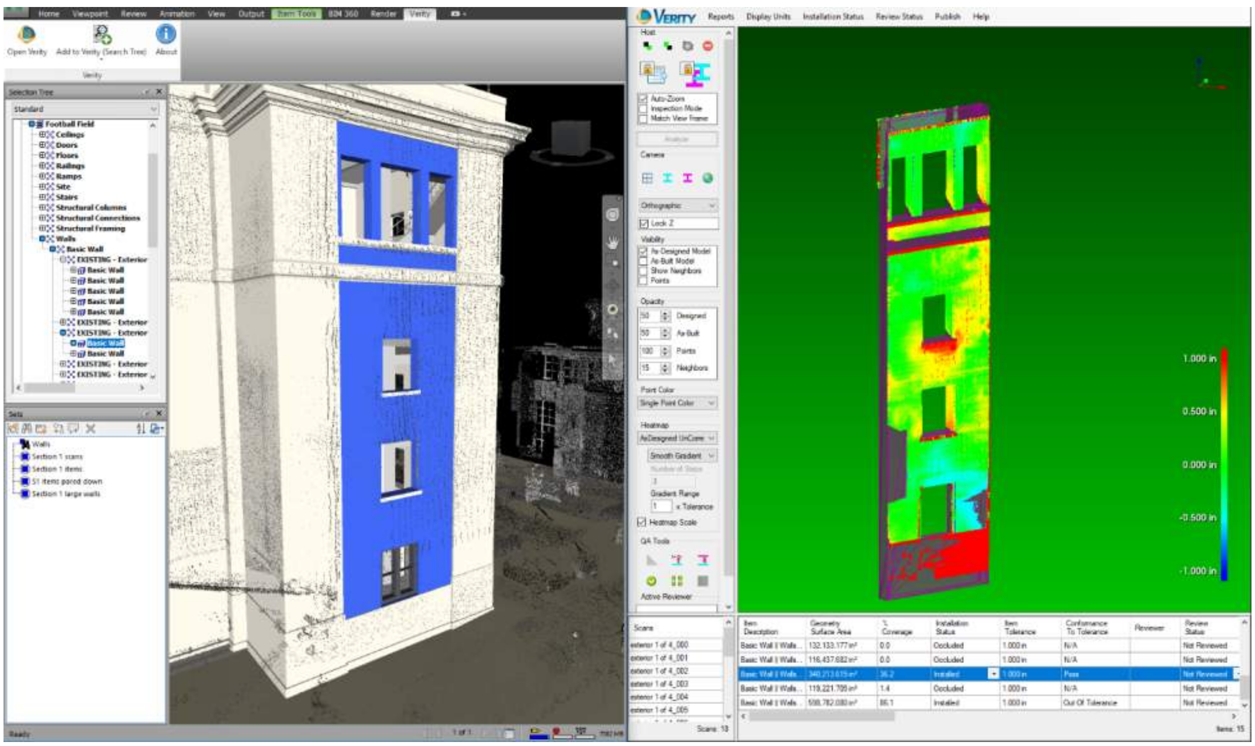


Figure 3: Comparing Revit model with point cloud using Verity and Navisworks

Manual Survey

If all else fails, you may find yourself in the field with a hammer and tape measure. That's okay! Sometimes hands-on investigation is the best way to get the information you need. (But be careful with the hammer.) Afterwards, this information can be incorporated into your BIM project. (How? See "Level of Confidence" for more information.)

Strategic Modeling

All right, you've collected every bit of information available for your building. Time to start modeling!

> *Do you have to model that?*
>
> It's time for another reality check. If you don't *have* to model an existing element, maybe you shouldn't.

Determining Model Scope

Maybe you've got a contract to model the entire existing building—great. Maybe you've got such good existing documentation that it's actually easy to model the whole thing—great. Maybe the work is so extensive that you need to model the whole thing for coordination purposes…great?

But maybe the scope of your part of the renovation is fairly limited. Maybe it's confined to specific areas, and you're leaving the rest of the building alone. In that case, why would you model everything? Especially if you're a subconsultant and can take advantage of the architect's work to use as backgrounds that provide context for your elements. (Sorry architects, there aren't usually any shortcuts for you.)

For architects and MEP engineers, the entire building is often in your scope of work, since you're dealing with details as universal as paint colors and light fixtures. But since structural engineers don't care about paint colors and light fixtures (at least professionally), it's a very relevant question for you.

If the structural contract specifies a full-building model, then "what to model" is an easy question to answer. But if the structural scope doesn't require it, and the fee isn't high enough to do more, then you have to make decisions.

One approach is to model existing elements that are being modified or that directly connect to new structural elements. For areas not being structurally modified, the architectural floor plan (often just the walls) can be used as a background. Please resist the urge to use detail lines to represent existing framing in plan. If it's that important to see the beam, go ahead and model it. When you're cutting sections later, you'll be glad you did.

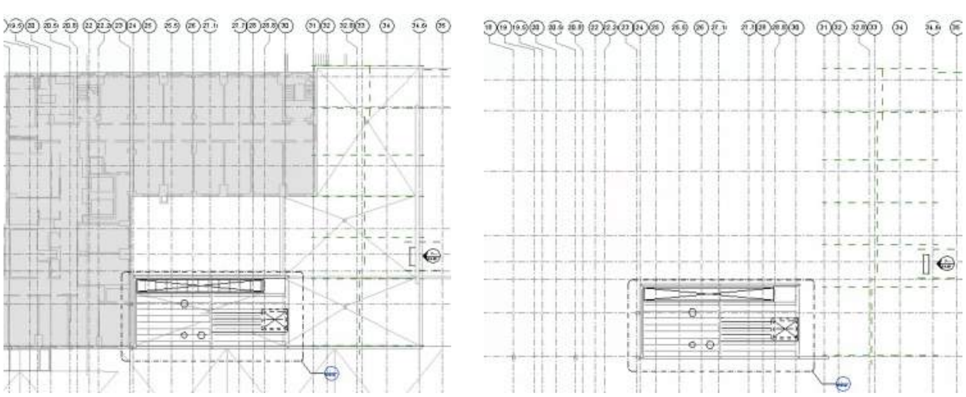


Figure 4: (Left)The final drawing. (Right)The actual modeled elements.

Dealing with the Unknown

Even the best existing building model will have some "known unknowns"—information you know you don't have, but that you need to represent anyway. By definition, *all* existing elements have some level of uncertainty. You weren't there when it was put up and you can't see inside it now, so there's probably going to be *something* you don't know about each element.

This has interesting implications for a 3D model. With 2D CAD files, you can draw a line, label it "EXISTING BEAM (V.I.F.)," and no one can read more information into it than you intended. But as soon as you put that beam in Revit, it *looks* real. It has a size in all 3 dimensions. It has a location on plan *and* in elevation. If what you modeled was simply your best guess of the existing condition, how do you convey that ambiguity to other people using the model?

Placeholder Elements

One way is simply to use a deliberately generic element. You might approximate a steel beam with a rectangular cross-section or model all concrete beams as 24"x24". These could be separate families or special types within a regular family. Either way, the name (of the family or type or both) should indicate the placeholder status.

If you're *really* concerned with assumptions, there's no limit to your placeholder creativity. This "steel beam" looks fine on plan, but in sections or 3D views it's a transparent green exclamation point. It has depth and width parameters to approximate the assumed size, but it almost literally shouts "Don't trust me!"

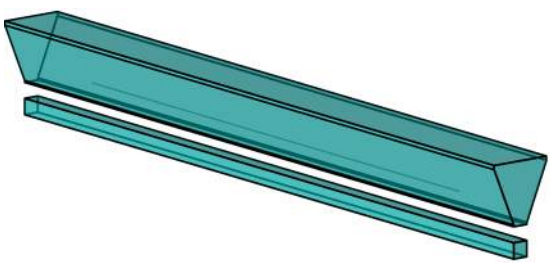


Figure 5: A really fake beam

Generic tags are also an option. Existing steel framing is often identified by its nominal depth (e.g. W12) instead of by depth and weight (W12x16) as a new beam would be.

You could even take it a step farther and use wall or floor elements instead of individual beams or columns. You can't misinterpret information that doesn't exist.

Level of Confidence

Level of Confidence (LOC) is a framework developed by Silman to communicate how much we know about the elements we place in our model—essentially, it's a way to identify which "data gathering" method was used to inform the element's size, shape, and location.

Here's the essence of LOC:

LOC 0 = "Assumed based on existing documentation or symmetry." This is the most generic level. Your assumption could be based on a few different things, but the bottom line is that you don't actually know what's there. It's the default level for all elements, unless you acquire information that would move it up a level.

LOC 1 = "Verified through NDE." For this level, you have a bit more information, but you still haven't laid eyes on the actual element.

LOC 2 = "Verified through probes." Now, you've seen the element in the field and confirmed that it is where it says it is.

Once you have your LOC data, you can add it as a Revit parameter to the appropriate categories—usually beams and columns. Then elements can be tagged or views can be color-coded to communicate the certainty…or lack thereof.

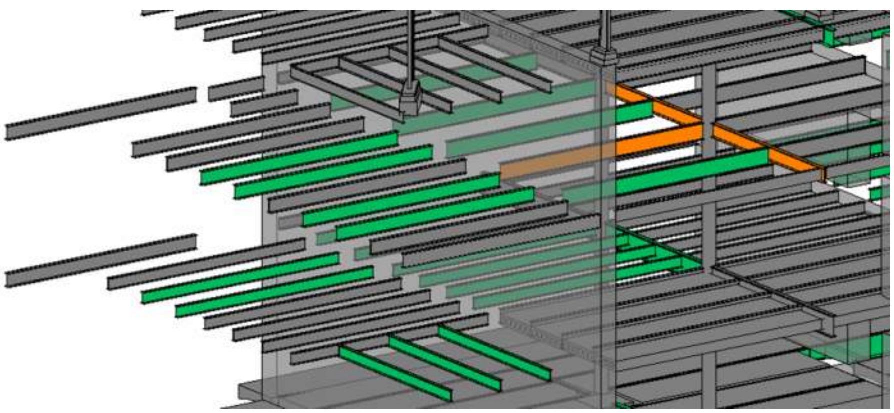


Figure 6: LOC 0 (gray), 1 (green) and 2 (orange)

This LOC framework can be adapted and expanded as needed for individual projects. Maybe you have 3 parameters: LOC-Size, LOC-Location, and LOC-Material that you combine to create an even clearer picture of the data. How far you take it is up to you.

Communication

Even with the best intentions and execution, technology can't compensate for a lack of communication. Too much in Revit looks more "real" than it is—whether it's unconfirmed existing construction or partially-design new construction—to rely solely on the model for the communication of design intent. A well-design BIM Execution Plan can help with that, as can regular coordination meetings, but you may need text in the model or on the drawings that spell out the limits of your information.

It doesn’t have to be long; a few sentences will do. Here’s a sample:

> Dimensions and elevations of existing construction given in structural drawings are based on information contained in various original design and constructions documents (provided by the owner) and limited field observations and measurements. Contractor shall verify all information pertaining to existing conditions by actual measurement and observation at the site. All discrepancies between actual conditions and those shown in the contract documents shall be reported to Engineer of Record for evaluation before affected construction is put in place.

Please note that this is a *sample only*. You will want to clear any language like this with your project manager and the design team, and possibly your legal advisor.

Mastering Phases

So far, this handout has covered the mechanics of modeling existing elements of a building, but the reason for doing that is almost always that you’re doing to model some new elements too. That means you have to be able distinguish between what was already there and what’s being added. Thoughtful use of phasing will be an absolute lifesaver as you create your construction documents.

Project Phases

Most Revit templates include two phases by default: Existing, and New Construction. Much of the time, these are all you need. In other situations, you may need to add additional phases before, between, or after these two. Maybe the renovation requires some temporary structure to be installed prior to demolition, and you want to show that as new construction on some views and as existing or demolished on others. Maybe the new construction efforts will actually be divided into “Phase 1” and “Phase 2.” Or maybe your existing building was modified after its initial construction, and you want to keep track of its evolution.

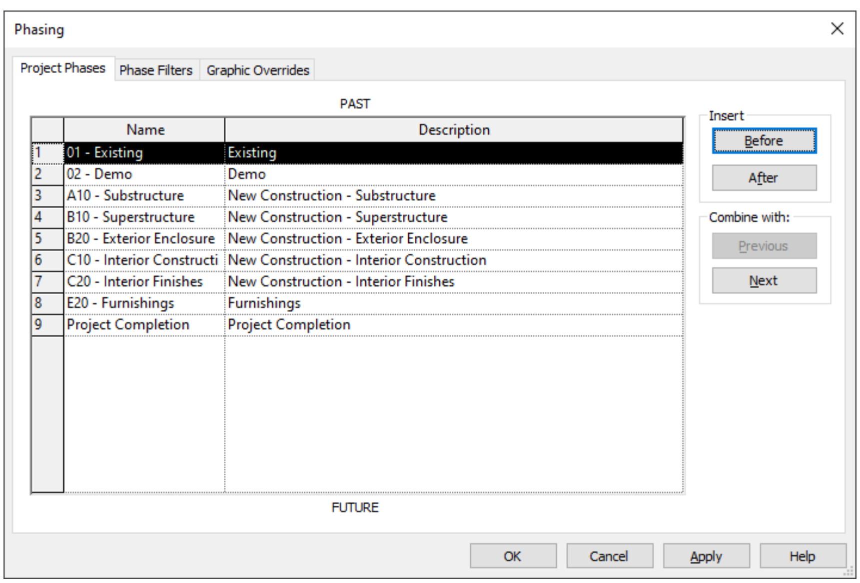
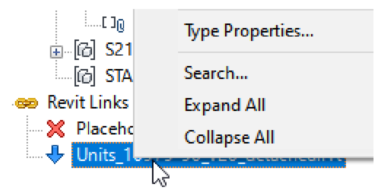


Figure 7: If two phases aren't enough, try the Construction template...it has nine!

Notice that in this dialog, there are no “move up” and “move down” buttons. You can’t change a phase’s position in the sequence after it’s been created. If you make a mistake or change your mind, though, you’re not entirely locked in. Instead, simply add the new phase where it belongs and use “combine with” to merge the old phase with the one immediately before or after it.

(If you already have elements in the old phase, you may want to re-assign them before you merge the phases. The next sections will cover how to assign and identify those elements.)

Phases and Linked Models



It’s convenient if all linked models have the same phases, but it’s not mandatory. If they don’t match, you need to coordinate them via Phase Mapping in the *Type Properties* of the linked model.

In the example below, the host model has an intermediate phase called “Stabilization” between Existing and New Construction. You can choose which phase in the linked model to use as its equivalent.

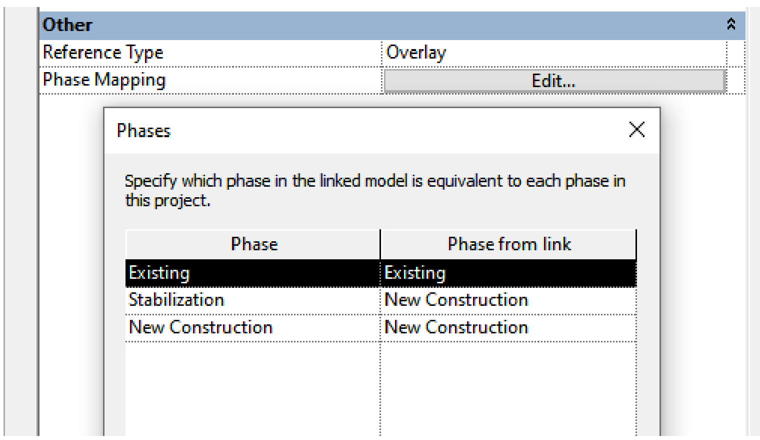


Figure 8: Phase Mapping

Once you have the phases you need, you can assign them to elements and views. Let’s start with views.

Phases for Views

Each view (unless it's a drafting view or legend) has two phase-related parameters: "Phase" and "Phase Filter." "Phase" simply sets the current phase for the view, and "Phase Filter" defines what elements are displayed in the view—and how.

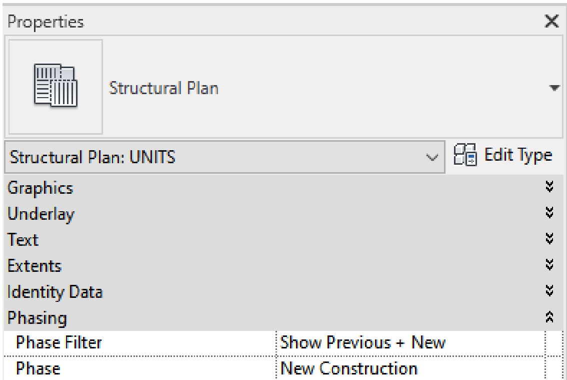


Figure 9: View Phase Parameters

The Phase property is fairly straightforward.

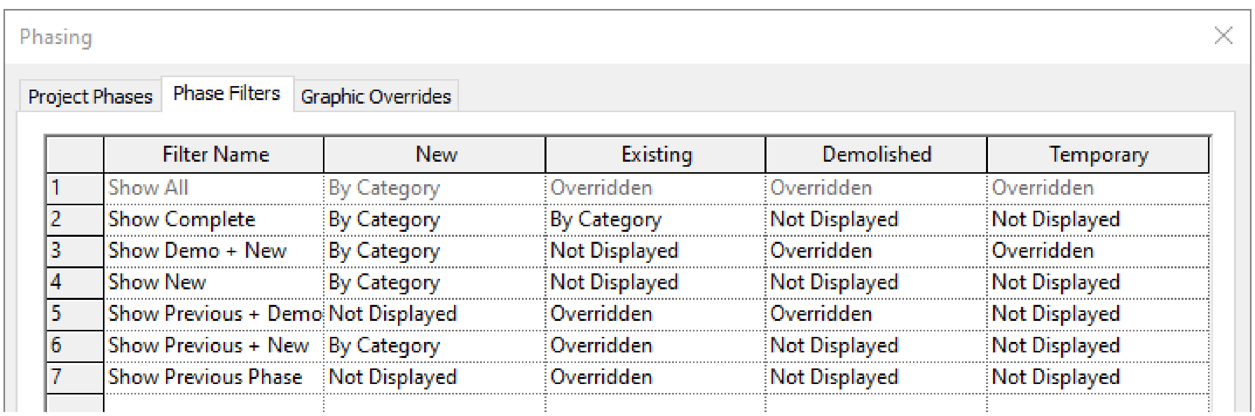
Phase Filters are where things start to get complicated.

The main thing to remember is that "New," in a phase filter, means *current*. It has no relation to the phase name "New Construction."

More on this in a bit.

Phase Filters

Here are Revit's default Phase Filters (in the architectural & structural templates):



	Filter Name	New	Existing	Demolished	Temporary
1	Show All	By Category	Overridden	Overridden	Overridden
2	Show Complete	By Category	By Category	Not Displayed	Not Displayed
3	Show Demo + New	By Category	Not Displayed	Overridden	Overridden
4	Show New	By Category	Not Displayed	Not Displayed	Not Displayed
5	Show Previous + Demo	Not Displayed	Overridden	Overridden	Not Displayed
6	Show Previous + New	By Category	Overridden	Not Displayed	Not Displayed
7	Show Previous Phase	Not Displayed	Overridden	Not Displayed	Not Displayed

Figure 10: Revit Phase Filters

Each Phase Status—New, Existing, Demolished, and Temporary—can be displayed in one of three ways:

- **By Category:** Elements are displayed with the settings from Object Styles
- **Overridden:** Elements are displayed with the settings from the "Graphic Overrides" tab
- **Not Displayed:** Elements are not shown in the view

And what determines what New, Existing, Demolished, or Temporary *means*? Stay tuned.

But first…

> *Phase Filters and Linked Models*
>
> In order to for a Phase Filter to affect a linked model, it MUST exist in BOTH the host model AND the linked model. Otherwise, the view acts as though a “none” filter has been applied and shows all elements with no overrides.
>
> 98% of the time, the default filters will be all you need.
>
> For the other 2%, you MUST tell ALL your collaborators about the new filters and convince them to adopt them too.
>
> If you’re thinking about renaming the filters “so they make more sense,” please don’t. That action will have downstream consequences every time you send or receive a model.
>
> </rant>

Phases for Elements

Now it’s time for the third piece of the phase puzzle: Elements. All 3D model elements have instance parameters for “Phase Created” and “Phase Demolished.”

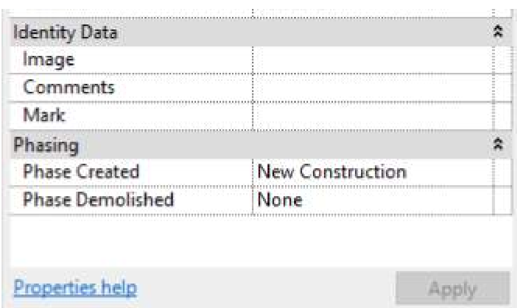


Figure 11: Element Phase Parameters

The default value for Phase Created is *the current phase of the view*. Remember that—it’s important.

The default value for Phase Demolished is *none*. Revit assumes that when you put something in, you intend to keep it.

Putting It Together

Remember the four columns in Phase Filters? (New, Existing, Demolished, and Temporary). The values of “Phase Created” and “Phase Demolished” combine with the View Phase to define which status an object is controlled by. The charts below show some sample creation/demolition combinations and the resulting filter status.

Current View Phase = New Construction

Phase Created	Phase Demolished	Phase Filter Status
Existing	None	**Existing**
Existing	New Construction	**Demolished**
New Construction	New Construction	**Temporary**
New Construction	None	**New**

Current View Phase = Existing

Phase Created	Phase Demolished	Phase Filter Status
Existing	None	**New**
Existing	New Construction	**New**
Existing	Existing	**Temporary**
New Construction	None	**n/a**

With a little practice, you can see how view phase, element phases, and phase filters work together to control object display, and use that understanding to show the objects you need.

One more thought on view & element phases: Beware of ghost elements!

Let's say you're working in a view with its Phase set to "New Construction" and its Phase Filter set to "Show Previous + Demo." (Per Figure 10, *New* and *Temporary* elements are not displayed while *Existing* and *Demolished* elements are displayed with phase graphic overrides.) If you try to add an element to a view (like a beam or column), *you will not be able to see it*—because your current Phase is "New Construction" and that's applied to the "Phase Created" parameter for new elements, but "new" elements are not displayed because of the phase filter! This element will still exist in the project, but you'll have to either change its phase properties or those of the view before you'll be able to see it (or switch to a different view). To avoid this, be sure to set your view's current phase appropriately before creating elements.

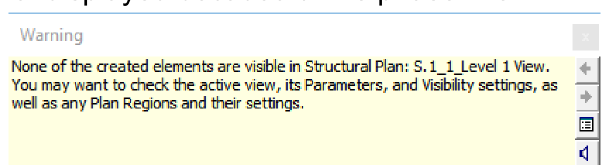


Figure 12: Warning for "ghost" elements

Phase Graphic Overrides

Let's back up a bit now for the last tab in Revit's Phasing dialog: Graphic Overrides. This is the final step in controlling how elements are displayed based on phase.

Here are the default settings:

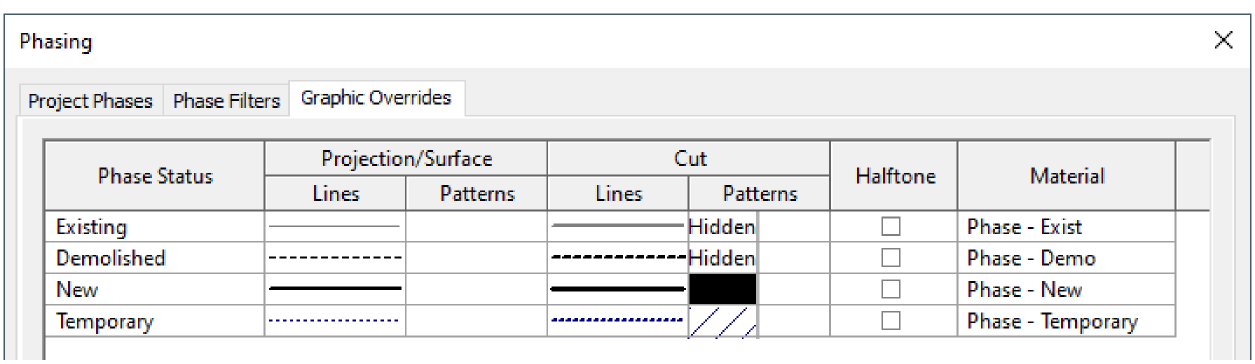


Figure 13: Default phase graphic overrides

Just like with other visibility settings, you can choose display options for lines and patterns for surfaces and cut faces of elements.

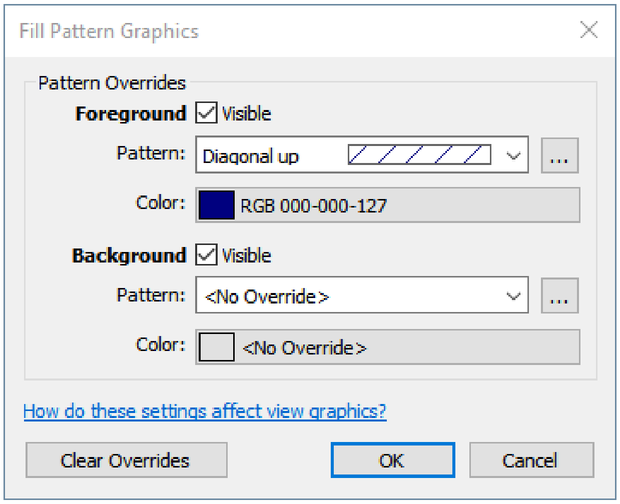


Figure 14: Pattern Overrides

As of Revit 2019, fill patterns can have a foreground *and* a background pattern and color.

There are a few things to know about these overrides, though.

First, they affect *every* element in that Phase Status. So if you set Existing elements to have a projection line weight of 2, *all* "existing" elements (as defined by the element/view phases) will have that line weight, regardless of original object style.

That might work for you, but you might not be willing to have all materials represented identically. In that case, you'll need to employ other techniques (such as filters) to get more control over the object display.

Second, these pattern overrides work flawlessly…for *component* families. For *system* families, their cut patterns are based on the "Phase – Exist" material instead. Here's what you need to know about the image below, of a section in Revit:

- **Elements in View:** Concrete wall, beam, floor. Phase Created = Existing.
- **View Phase & Phase Filter:** New Construction, Show all
- **View Style:** Hidden Line
- **Cut Pattern Overrides:** Foreground patterns are not overridden; background pattern is set to solid gray.

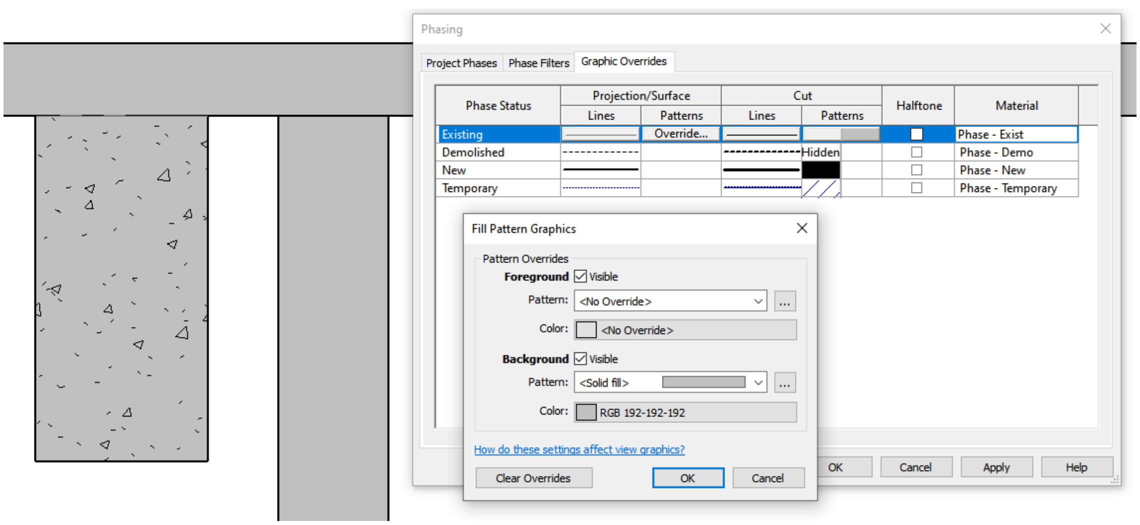


Figure 15: Component and System Families respond differently to Phase Graphic Overrides

There is no good reason why the wall and floor do not display the same patterns as the beam. What appears to be happening is that the "Phase – Exist" material (from the "Material" column in the Graphic Overrides dialog) is being applied to the system families and not the component families—even though it's intended to be used only in shaded or rendered views.

It's possible to get around this by removing "Phase – Exist" as a material override, but this will negatively affect shaded and rendered views. Not recommended.

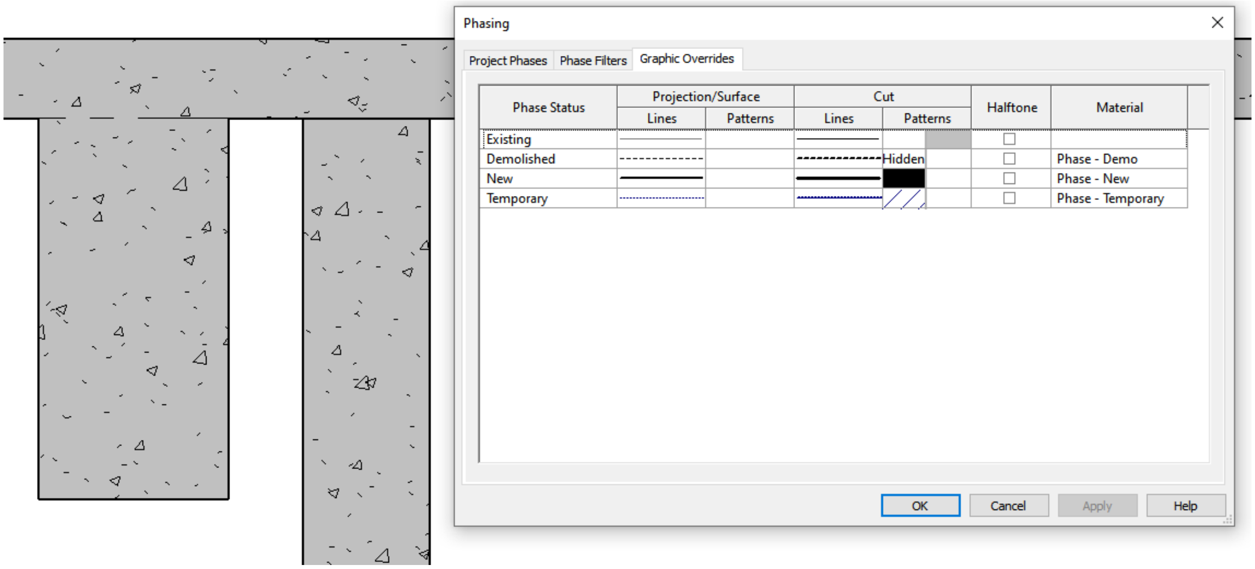


Figure 16: Removing Material restores fill patterns

This bug has existed since at least Revit 2016. No fix appears to be planned.

Workaround for Phase Graphic Overrides

The easiest solution to this Phase Graphic bug is to choose one line weight and one fill pattern for all of your existing elements. Again, 98% of time this is fine.

For the other 2%, you will need filters. There are as many options for which parameters and criteria to use as there are parameters in Revit—you will have to make your own decision for your firm and your project.

The one limitation? You can't filter by "Phase Created" or "Phase Demolished." ☹

Demolition

Before getting into the methods of demolishing elements, let's make one thing quite clear:

Demolition is not a phase.

Did you notice that Revit's default Project Phases do *not* include one called "Demolition"? That's because, in Revit's world, "demolition" is both an action and a state of being. If an element is created in the Existing phase and demolished in New Construction, it could be displayed as new, existing or demolished—or not displayed at all—depending on the Phase and Phase Filter of the current view. By adjusting those combinations, 98% of the time you can achieve your requirements without creating a separate demolition phase.

All right, that's settled. Time for the mechanics of demolition.

Demolishing an entire element generally couldn't be easier. Either use the Properties palette to adjust the Phase Demolished parameter or grab the "sledgehammer" and demo items by clicking on them. (Isn't it nice when software has a bit of a sense of humor?)

Demolishing *part* of an element takes a little more thought. There's no built-in method to cut off half of a steel beam and re-support what's left on a new one. But that doesn't mean you don't have options.

Split Elements

If your scenario allows it, just use the Split tool on your element and demolish as needed. You can even join the halves back together afterward, so it looks nice in "existing condition" views.

Doors & Windows

This is one of the sneakiest ways to demolish elements. Placing a "new" door or window in an "existing" wall automatically demolishes the affected wall! There's no need to create a separate opening, and it's one of the easiest ways to see why you don't need a "demo" phase.

But it gets even better! If you *demolish* an "existing" door, the infill wall is automatically created too! This infill piece has fewer parameters than a regular wall, but you can change its type, which is usually all you'd need to do.

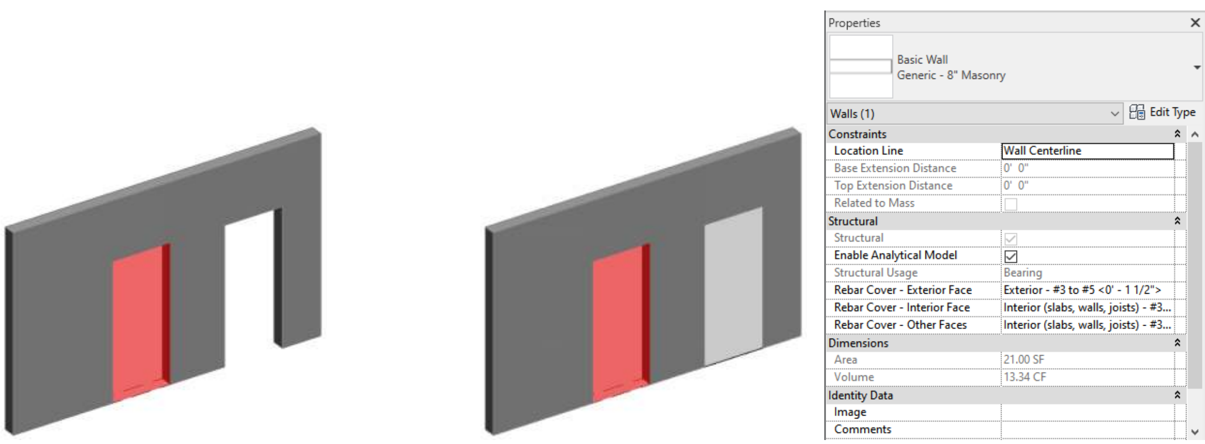


Figure 17: Existing wall with new door; Existing wall with new & infill door

Doors and windows are much more flexible than other opening methods like Wall Opening or Opening by Face. "Demolishing a door" instead of "infilling an opening" takes a bit of mental gymnastics, but once you get used to it, it's very easy.

Void Families

Component void families are another relatively flexible demolition method, and especially useful for floors.

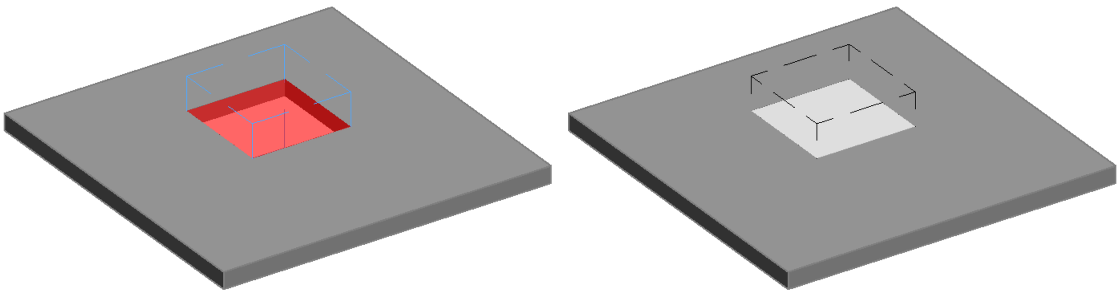


Figure 18: Floor cut with generic model void family; floor with demolished void family

What makes voids nice for floors is the ability to build the symbolic "X" directly into the family to be used in plan graphics. Two caveats, though: 1) When creating new openings with a void, the edges in plan will need to be overridden with the Linework tool in order to be visible. 2) Although demolishing a void creates an infill floor, similar to walls/doors, this infill floor cannot be selected or modified.

Parts

Parts in Revit can be used to demolish portions of an element while retaining the integrity of the original element.

This isn't the place for a full explanation of the Parts features. They could fill up an entire class on their own (as a search for "Revit parts" will show). Let's assume you already know how to divide an object into parts, and the pros and cons of doing so.

Once you have your parts, check out the Phasing section of the Properties dialog. In addition to the standard "Phase Created" and "Phase Demolished" parameters, you also have checkboxes for "Phase Created By Original" and "Phase Demolished By Original."

By default, both boxes are checked. But if you uncheck one (or both), you can set the creation and demolition phases for each part independently. This gives you a lot of flexibility for displaying the element in an intact state or a modified one.

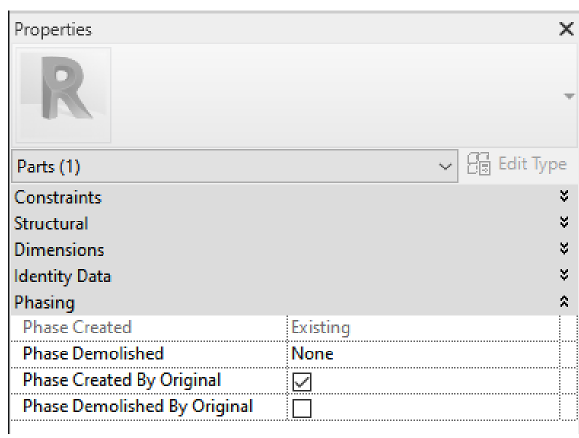


Figure 19: Phase parameters for Parts

The main downside of Parts, of course, is that they are considered a separate object category and no longer inherit the object styles of their parent object. If you can live with that, though, it could be a useful approach.

Special Category: Trusses

Truss elements require special treatment for selective demolition. That's because the truss "skeleton" is a single object, even though the webs and chords are separate 3D elements. To demolish a single piece of a truss, you need to use "Remove Truss Family" first. Unpinning the element isn't enough! But do this carefully, because it means your truss is no longer a unified element but instead is made up of regular beams and braces.

Special Category: Shaft Openings

Last but not least, Shaft Opening elements also deserve special mention. This tool is great for new buildings, because it's an opening type that supports multiple floors and symbolic lines (the "X" you see on plan). HOWEVER, Shaft Openings do not support phases!

A Shaft Opening will cut all floors in all phases, regardless of the creation/demolition settings for the shaft or the floor. This means that "new" shafts will be visible in "existing" views, and "existing" shafts cannot be filled in with "new" floors.

Use extreme care when including Shaft Openings in existing buildings. Their ease of creation may not makeup for their lack of flexibility in phase behavior.

And there's one more approach to demolished elements: Don't model them! Before you spend time and money modeling something that's just going to be eliminated, make sure it's worth it. Maybe a 2D filled region or other "mass" approach would work just as well for your purposes.

Conclusion

Hopefully you now have a better idea of the risks, challenges, and rewards of modeling existing buildings. It's true that there are many traps waiting along the way, but with some careful planning and a thorough understanding of the available tools, an effective and efficient model is well within reach.