MEP21252

# Revit Plug-in: Automated Hanger and Seismic Bracing Layout and Design for MEP Systems

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## Learning Objectives

- Learn how Revit can be used to efficiently model conduit, pipe, duct, and tray
- Discover requirements and challenges for hanging and bracing MEP systems
- Understand typical workflow for designing and seismic bracing and how this can be simplified with the DEWALT plug-in
- Learn how to export information from the DEWALT plug-in for layout, prefab and procurement

## Description

This session will present the new DEWALT HangerWorks plug-in for Autodesk Revit which automates the placement and design of hangers and trapeze assemblies for common MEP (mechanical, electrical, and plumbing) systems such as pipe, duct, conduit, and cable trays. The placement of these assemblies has historically been based on “rule of thumb” sizing and spacing and/or prescriptive rules from various trade-specific handbooks that do not necessarily comply with current building-code requirements or structural point-load limitations. Modeling MEP systems in Revit software offers many advantages for coordination, prefabrication, consolidation of parallel runs, and placement of cast-in-place hanger inserts. This new tool analyzes these systems, and automatically places hanger/trapeze assemblies, anchors, and seismic bracing per building-code requirements with engineering calculation reports automatically generated. Product-specific content is placed in the model with exporting schedules for field layout, prefabrication, and procurement. This session features Revit and BIM 360 Layout. AIA Approved

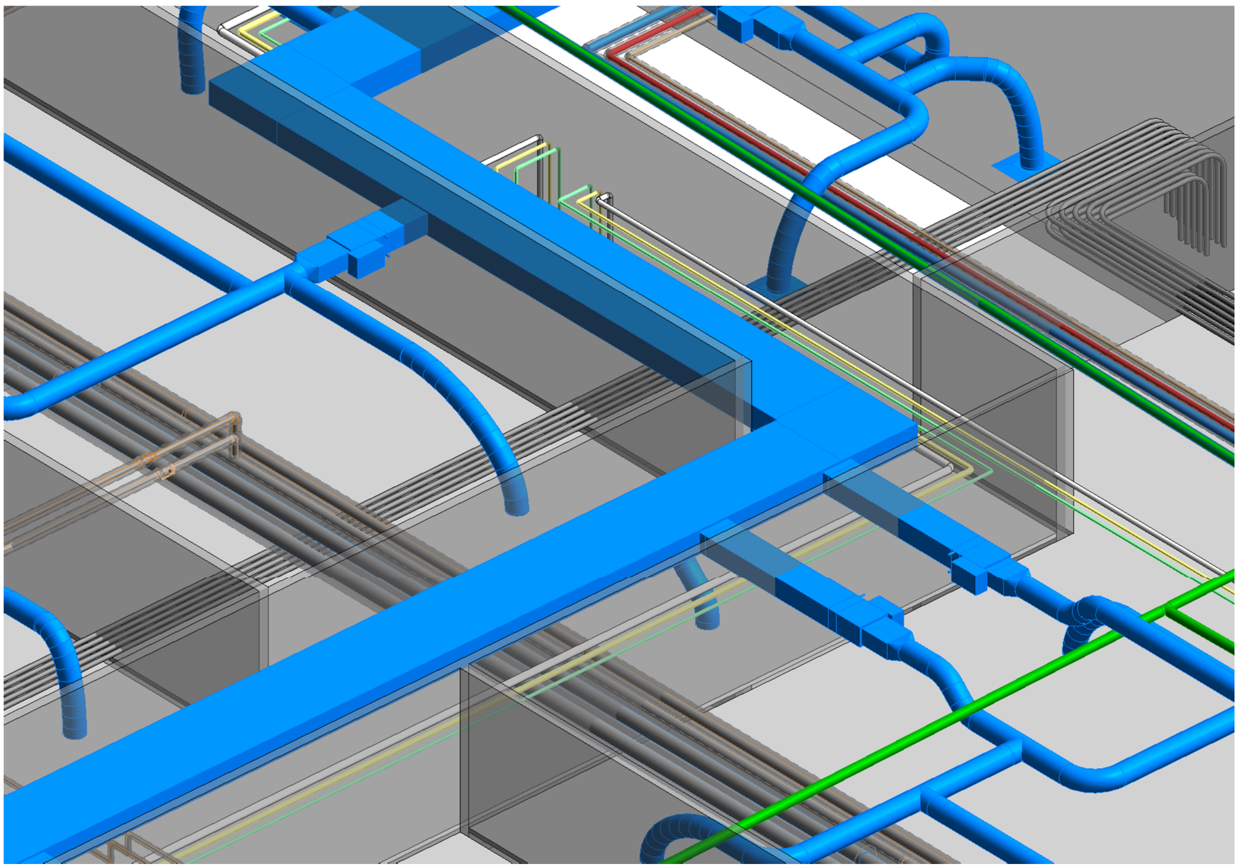
## Your AU Expert(s)

Alan Espinoza is a virtual design and construction modeler in the Virtual Design and Construction Group at MMC Contractors. Espinoza joined the Virtual Design and Construction department at MMC Contractors in May 2011, and he completed his Master of Engineering Technology and Construction Management degree with an emphasis in Building Information Modeling (BIM) from Pittsburg State University in May 2012. From May 2011 to May 2014, Espinoza led the BIM efforts on MMC Contractors largest contract to date—Martin Army Community Hospital at Fort Benning. He spent the next year working for a Boston-based general contractor, where he gained experience on a Brookline, Massachusetts, hotel before returning to his true passion of working for a mechanical contractor. Espinoza is proficient in many modeling software programs and tablet applications, including Revit software, Navisworks software, AutoCAD software, Fabrication CADmep software, and Bluebeam Revu.

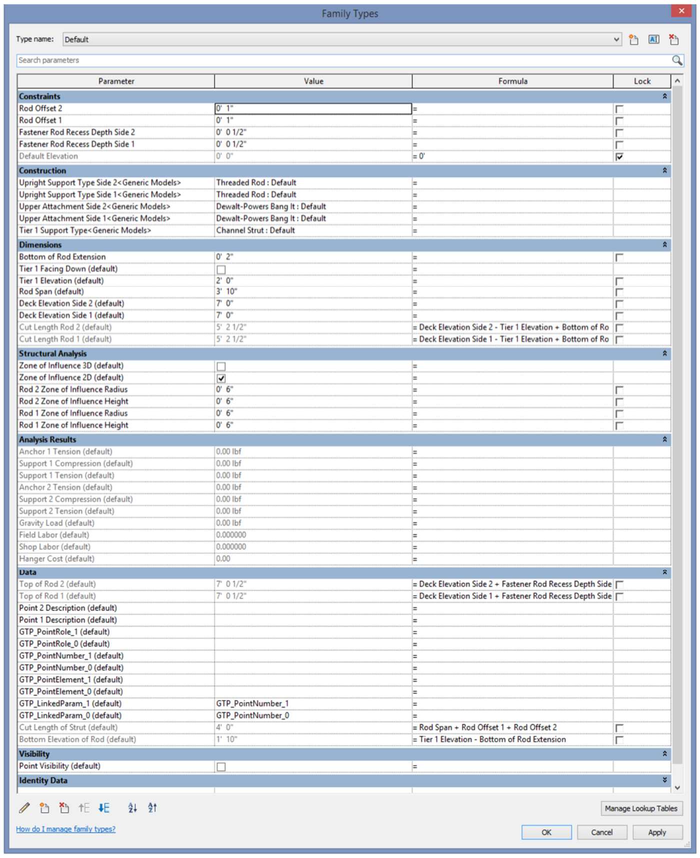
Jake Olsen is the Vice President of Field Engineering at DEWALT. He holds an Undergraduate Degree in Industrial Engineering and a Master's Degree in Structural Engineering. He is a registered Professional Civil Engineer in California. Jake has more than 15 years of experience in the construction field from engineering consulting to construction product design and manufacturing. In his current role, he leads a team of engineers that work with designers and contractors from the office to the fabrication shop to the jobsite to improve efficiency by developing both innovative products and industry specific technology solutions.

## Introduction: BIM for MEP

Mechanical, Electrical, Plumbing and Fire Sprinkler Contractors (MEP Contractors) can benefit greatly from modeling their systems prior to construction. A well-constructed 3D model (BIM) of an MEP system will contain both dimensional and spatial information, as well as detailed parametric data on the products, materials, cost and labor required to construct the modeled system.  The spatial model facilitates coordination with other building components, prefabrication and jobsite layout, while the parametric data enables efficient take-offs, estimating and material planning.



*Revit Model of Various MEP Systems*



Family Types

Type name: Default

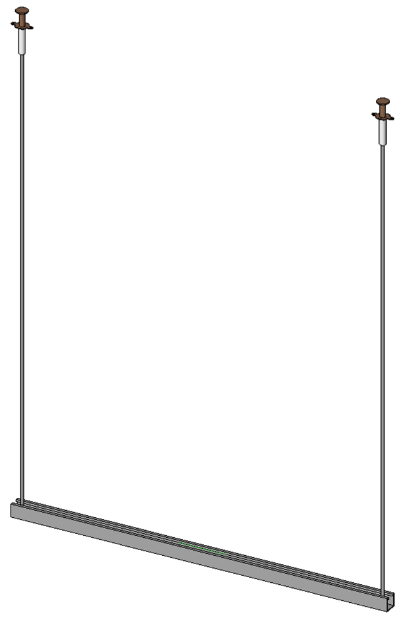
Search parameters

| Parameter | Value | Formula | Lock |
|---|---|---|---|
| **Constraints** | | | |
| Rod Offset 2 | 0' 1" | = | |
| Rod Offset 1 | 0' 1" | = | |
| Fastener Rod Recess Depth Side 2 | 0' 0 1/2" | = | |
| Fastener Rod Recess Depth Side 1 | 0' 0 1/2" | = | |
| Default Elevation | 0' 0" | = 0' | ✓ |
| **Construction** | | | |
| Upright Support Type Side 2<Generic Models> | Threaded Rod : Default | = | |
| Upright Support Type Side 1<Generic Models> | Threaded Rod : Default | = | |
| Upper Attachment Side 2<Generic Models> | Dewalt-Powers Bang It : Default | = | |
| Upper Attachment Side 1<Generic Models> | Dewalt-Powers Bang It : Default | = | |
| Tier 1 Support Type<Generic Models> | Channel Strut : Default | = | |
| **Dimensions** | | | |
| Bottom of Rod Extension | 0' 2" | = | |
| Tier 1 Facing Down (default) | ☐ | = | |
| Tier 1 Elevation (default) | 2' 0" | = | |
| Rod Span (default) | 3' 10" | = | |
| Deck Elevation Side 2 (default) | 7' 0" | = | |
| Deck Elevation Side 1 (default) | 7' 0" | = | |
| Cut Length Rod 2 (default) | 5' 2 1/2" | = Deck Elevation Side 2 - Tier 1 Elevation + Bottom of Ro | |
| Cut Length Rod 1 (default) | 5' 2 1/2" | = Deck Elevation Side 1 - Tier 1 Elevation + Bottom of Ro | |
| **Structural Analysis** | | | |
| Zone of Influence 3D (default) | ☐ | = | |
| Zone of Influence 2D (default) | ☑ | = | |
| Rod 2 Zone of Influence Radius | 0' 6" | = | |
| Rod 2 Zone of Influence Height | 0' 6" | = | |
| Rod 1 Zone of Influence Radius | 0' 6" | = | |
| Rod 1 Zone of Influence Height | 0' 6" | = | |
| **Analysis Results** | | | |
| Anchor 1 Tension (default) | 0.00 lbf | = | |
| Support 1 Compression (default) | 0.00 lbf | = | |
| Support 1 Tension (default) | 0.00 lbf | = | |
| Anchor 2 Tension (default) | 0.00 lbf | = | |
| Support 2 Compression (default) | 0.00 lbf | = | |
| Support 2 Tension (default) | 0.00 lbf | = | |
| Gravity Load (default) | 0.00 lbf | = | |
| Field Labor (default) | 0.000000 | = | |
| Shop Labor (default) | 0.000000 | = | |
| Hanger Cost (default) | 0.00 | = | |
| **Data** | | | |
| Top of Rod 2 (default) | 7' 0 1/2" | = Deck Elevation Side 2 + Fastener Rod Recess Depth Side | |
| Top of Rod 1 (default) | 7' 0 1/2" | = Deck Elevation Side 1 + Fastener Rod Recess Depth Side | |
| Point 2 Description (default) | | = | |
| Point 1 Description (default) | | = | |
| GTP_PointRole_1 (default) | | = | |
| GTP_PointRole_0 (default) | | = | |
| GTP_PointNumber_1 (default) | | = | |
| GTP_PointNumber_0 (default) | | = | |
| GTP_PointElement_1 (default) | | = | |
| GTP_PointElement_0 (default) | | = | |
| GTP_LinkedParam_1 (default) | GTP_PointNumber_1 | = | |
| GTP_LinkedParam_0 (default) | GTP_PointNumber_0 | = | |
| Cut Length of Strut (default) | 4' 0" | = Rod Span + Rod Offset 1 + Rod Offset 2 | |
| Bottom Elevation of Rod (default) | 1' 10" | = Tier 1 Elevation - Bottom of Rod Extension | |
| **Visibility** | | | |
| Point Visibility (default) | ☐ | = | |
| **Identity Data** | | | |

Manage Lookup Tables

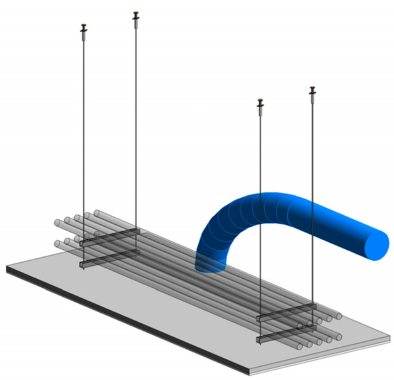
How do I manage family types?

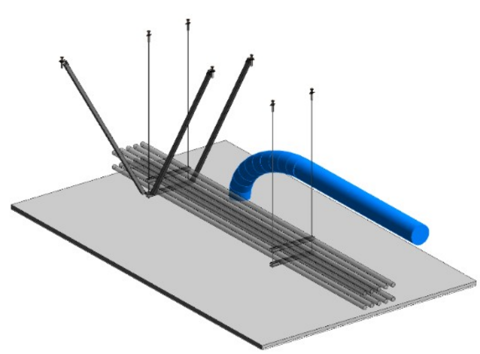
OK Cancel Apply



*HANGER ASSEMBLY AND PARAMETRIC DATA*

Building Information Models for MEP systems are often constructed in order of importance from the contractor's point of view: large pieces of equipment such as pumps, air-handlers or switch gear are designed in the model first, followed by the "distributed systems" that route throughout the building. Typical MEP distributed systems include: piping, duct, conduit and cable tray. After the distributed systems are in place, hangers and supports are added to the model and finally, when required, seismic bracing may be designed.





*HANGER SYSTEM AND HANGER SYSTEM WITH SEISMIC BRACING*

## Current Problems with Hangers and Braces in BIM

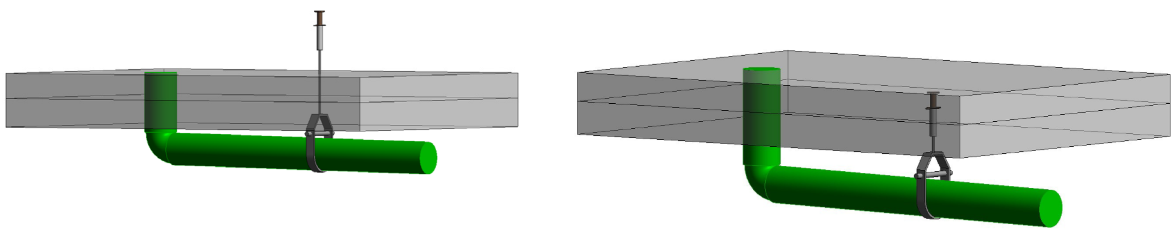
For hangers and braces, contractors typically look for efficiencies by reducing the amount of time spent placing hangers in the field. A simple way to do this, is to reduce the total number of hangers required to support a system – which can be done by supporting multiple pieces of pipe, duct or conduit on a single trapeze hanger. BIM facilitates this process by allowing the designer to systematically consolidate parallel systems such as a large amounts of conduit during the modeling process optimizing both the routing and installation of these systems.

*MULTI-TIERED TRAPEZE ASSEMBLY FOR CONDUIT*

An unintended consequence of this efficient routing is an increase in the loads on the hanger assembly and the upper attachment which is typically a concrete insert or beam clamp. These loads are important to understand. For example, the building structure may have limits on how much total weight can be supported in certain areas or individual limits on point loads. In most designs a structural engineer assumes a uniform "MEP Load" spread out across the entire floor slab which will not be the case when many individual hangers are reduced to fewer large trapeze assemblies. As structural engineers are increasingly involved in the BIM coordination process, their awareness of this problem is on the rise. Point load limits and requests for actual point loads are now common on many projects. A structural analysis of the actual point loads can result in a redesign of both the structural system and the MEP system.

Furthermore, the hanger hardware itself may not be able to support the weight. Components such as the strut, the threaded rod can easily be overloaded in complex hanger assemblies and need to be checked for capacity. Existing tables and charts for hanger sizing and spacing do not sufficiently address the myriad of combinations possible for typical MEP systems, and this critical design step for hanger assemblies is often over-looked by the project team.

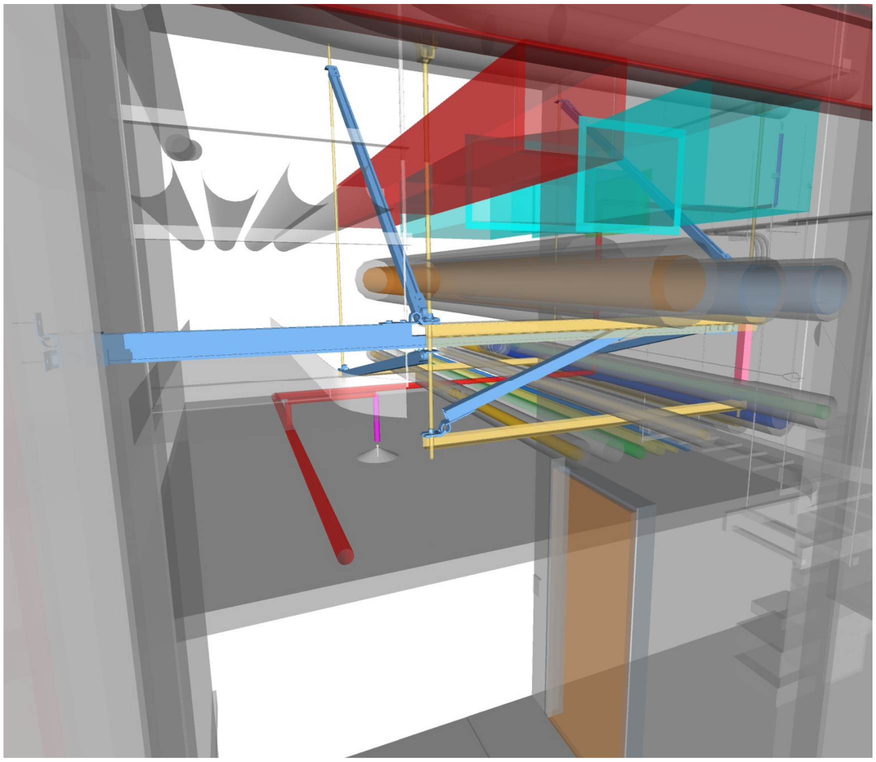
Another problem with hangers in BIM has to do with constructability. Currently hangers are added to an MEP system model when the various trades working on coordinating and eliminating clashes are confident that their respective systems are not going to move. This creates challenges when the systems are limited by size constraints of the overhead space, especially for certain types of hanger assemblies. Contractors often receive design models post-coordination, only to find that hangers and braces have not been considered or are not possible given the final location of the system. This extends the design process by requiring additional rounds of coordination, reducing the benefits of BIM. For example, the figure below shows a 4” sanitary line that was moved tight to structure to avoid ductwork, but in these configuration hangers cannot be placed.



*PROBLEMATIC PIPING LOCATIONS FOR HANGER PLACEMENT*

Seismic bracing is considerable and increasing problem in the BIM workflow as both the use of BIM, and the requirements for MEP systems to consider seismic are on the rise. The calculations required to properly hang and brace a distributed system in seismic zones are complex and typically require outside engineering. Since calculations are specific to the precise design and location of the MEP system, they are almost always started at the very end of coordination when contractors are certain their systems will not need to move any longer. This presents two distinct challenges. First, the space required to properly install hangers and braces may not be available due to clashes with other MEP systems. Secondly, the time between a completed modeling and coordination process and actual field installation is typically very short leaving the seismic engineer very little time to efficiently design and optimize the bracing layout.

With the coordination process typically already complete and a short window of time to complete seismic design process, seismic braces are typically only detailed on 2D documents outside of the model which again limits the benefits of BIM for the MEP contractor. Modeling seismic bracing during the initial design phases and throughout coordination would provide a significant improvement to this workflow.

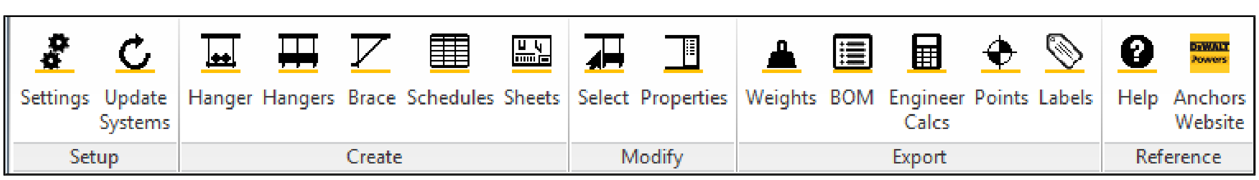


*Challenges Placing Seismic Bracing After Coordination in a Congested MEP Space*

## Introducing DEWALT HangerWorks

In 2012, DEWALT acquired Powers Fasteners, a leader in concrete anchoring technology including cast-in-place anchors used in hanger assemblies and several existing engineering analysis and design software packages. This acquisition, together with DEWALT's already strong relationships with the MEP contractor, put the company in an excellent position to understand and solve some of the challenges contractors have with the selection and design of hanger and bracing assemblies for common MEP systems. Building a BIM tool that facilitates the selection, design, fabrication, procurement and installation of hanger and bracing assemblies was an obvious solution. Autodesk Revit, as a parametric modeling tool with support of both RFA and ITM file types as well as providing key calculation functionality and interopability with 3rd party add-ins was an obvious platform to build on.

DEWALT is pleased to announce their new HangerWorks plugin for Revit which automates and simplifies significant portions of the hanger and bracing process.



HangerWorks adds three key pieces of functionality to Revit specifically for hangers and braces:

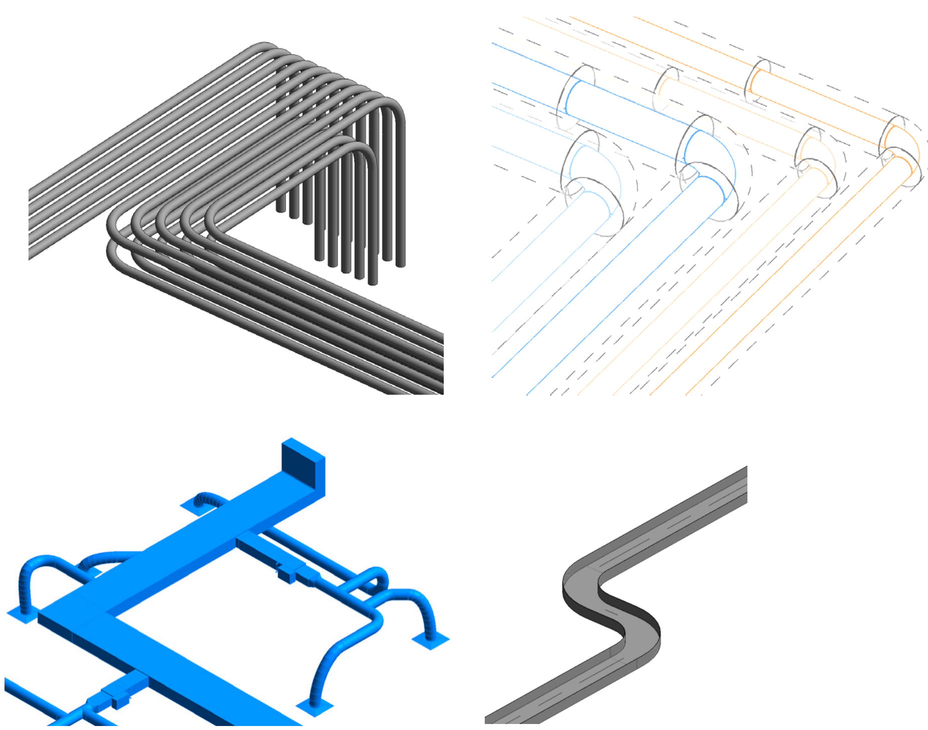
1. Analyzes existing systems in the Revit model including both .rfa and .itm systems and assigns weights to key distributed systems:
   - Pipe
   - Duct
   - Conduit
   - Cable Tray

2. Places hanger and bracing assemblies according to code requirements with real-time engineering calculations on the capacity of all components in the assembly. Assemblies are built with actual components from common hardware manufacturers.

3. Outputs key information to enable efficient design, procurement, fabrication, and installation workflows
   - Fabrication schedules for threaded rod and strut lengths, etc.
   - Procurement schedules with part numbers, SKUs, and cost information
   - Layout points for total stations
   - Engineering calculations for submittal packages

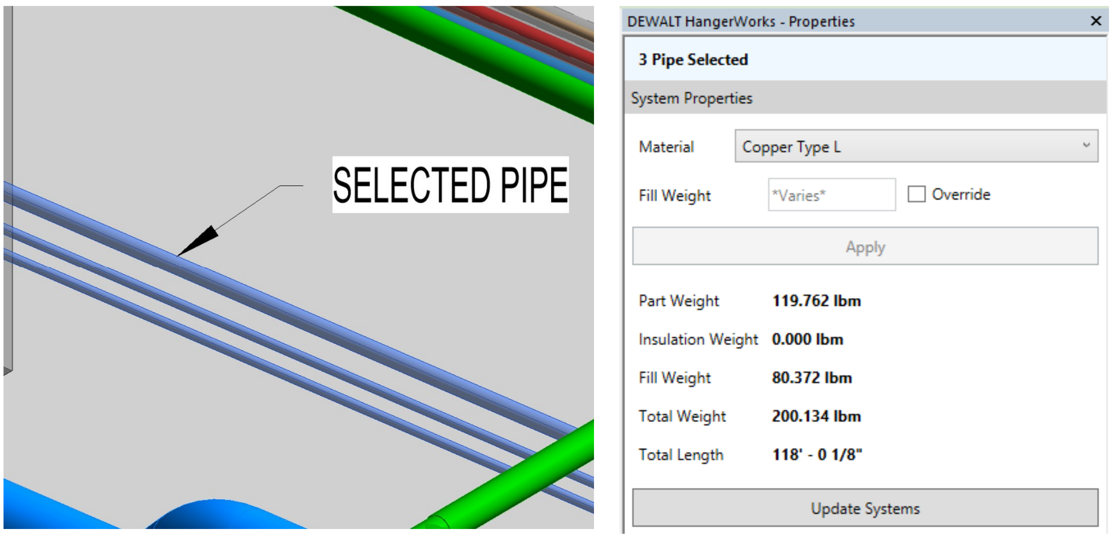
## Analysis and Loads

MEP contractors typically design four types of distributed systems: conduit, pipe, duct and cable tray.



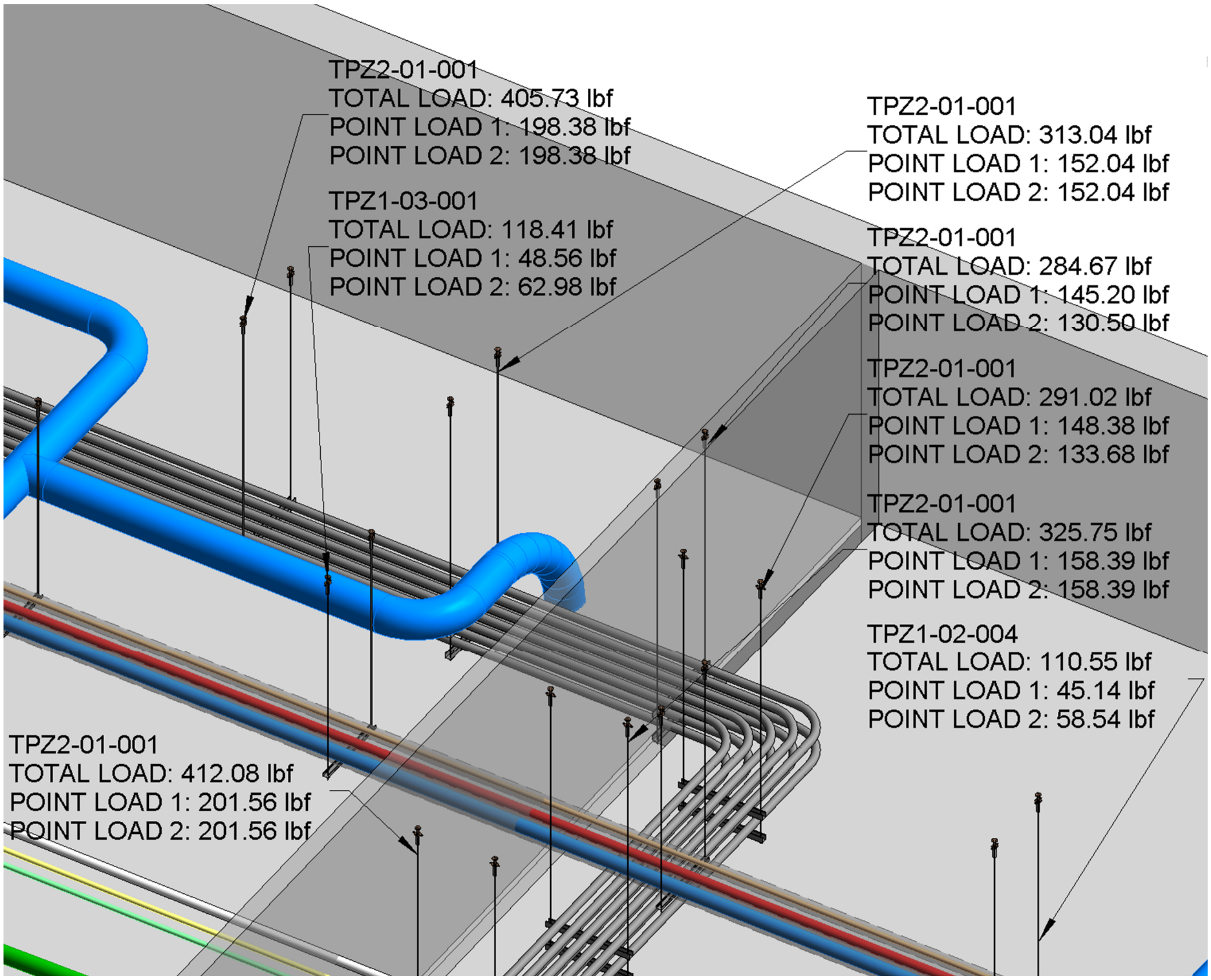
*EXAMPLES OF REVIT CONTENT FOR CONDUIT, PIPE, DUCT AND CABLE TRAY*

In order to perform the necessary engineering calculations to place hangers and seismic braces, the model must be updated with the weight for each of these systems which requires some analysis. Conduit, for example, will be filled with copper conductors, sprinkler pipe is filled with water, and duct typically carries only air.  For load calculations the total weight of the system must include both the distributed system itself, as well as what is being carried by it, for example the weight of a drain pipe and fittings, plus the water it will carry. HangerWorks analyzes each of these components and assigns a weight according to standard trade practices and/or code requirements. The user also has the option to manually adjust the weight assigned to the system which can be required for special cases such as OSHPD seismic calculations where the weight of water-filled conduit is required.




*HANGERWORKS PROPERTY ADJUSTMENT TOOL*

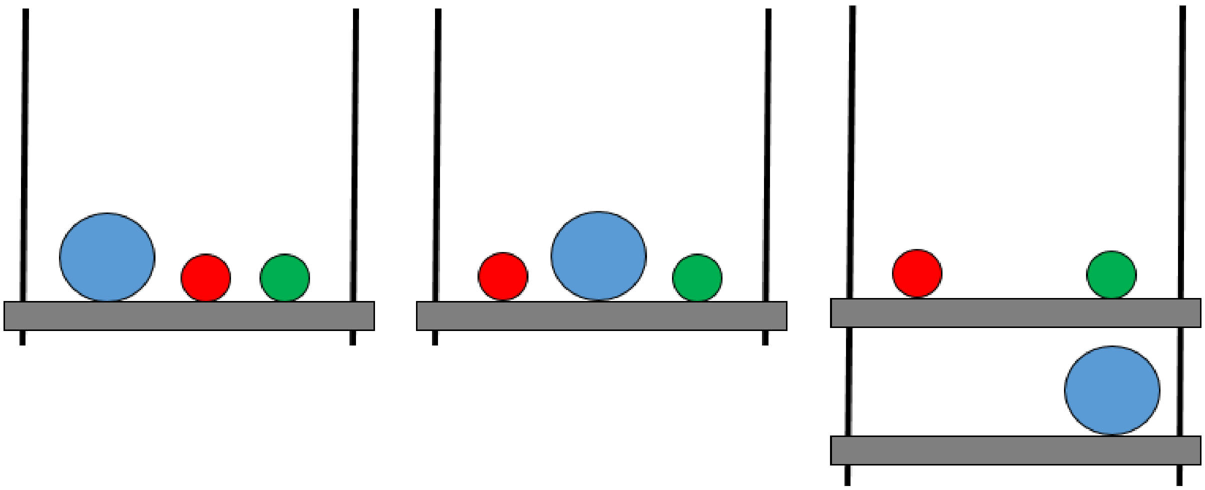
Once weights are assigned to the systems, the total weight at each hanger point (or load on the hanger components) can be calculated by summing the “tributary weight” to each hanger, which is based on the spacing distance between hangers.




*EXAMPLE OF POINT LOADS – ADDED AS PARAMETRIC DATA TO HANGER ASSEMBLIES*

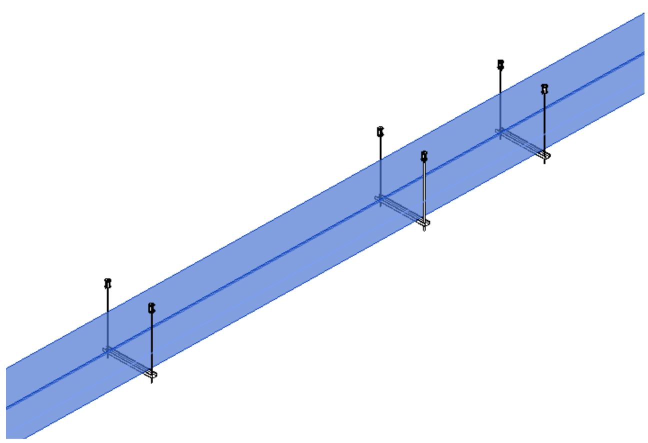
In the case of seismic conditions, the tributary weight at each seismic brace location is determined in a similar manner, with the tributary weight being determined by analyzing the distance between braces.

When multiple systems are supported by the same hanger in a “trapeze” condition with strut, the load on the components requires some additional consideration of where the weight is applied to the strut. For example, in the figure below, while the total load at the hanger location is the same, the loads and stress on each of the hanger components will be different in the three examples. Understanding these loads is critical to both standard hanger calculations and seismic calculations.



*DIFFERENT LOADING EXAMPLES ON A HANGER ASSEMBLY*

The loading calculations run real time as modeling is taking place in Revit – so as hangers and systems are moved around in the model, the point loads are automatically updated. If a hanger is moved too far where code or engineering properties are exceeded, the user will be notified, and will need to resize the particular hanger. For example, due to the spacing between hangers having been manually adjusted in the duct example below, the hangers will have different loads on them.



*EXAMPLE OF HANGERS WITH UNEQUAL SPACING*

From an engineering and safety standpoint, the load on these hangers and hanger components must be less than the strength of the hanger components and attachment to the structure. In other words – the hangers, strut, anchors, threaded rods, etc. must be strong enough to carry distributed systems they are supporting. Many types of prescriptive rules exist to ensure this (for example, hangers spaced no more than 15 feet), but there are also numerous cases where actual loads placed on hangers are difficult to determine (multiple systems suspended by a single trapeze hanger).

While there are specific engineering calculations included in the building code for each of these components, in practice most hangers are placed with “rule of thumb” methods or prescriptive guidelines from handbooks and trade manuals. In many cases, this results in hangers and attachments that are over designed, in other cases this results in conditions that are under-designed or unsafe.

Since the engineering calculations required by the building code can be complex, and with hundreds of different hanger assemblies on a typical project, it is currently impractical for contractors and MEP Engineers to go through the calculations needed to properly design each of the hangers. For example, the equations from ACI 318 Chapter 17 that are required by the building code to determine the tension capacity of a concrete insert are provided below:

17.4.1.2 The nominal strength of an anchor in tension, $N_{sa}$, shall not exceed

$$N_{sa} = A_{se,N} f_{uta} \quad (17.4.1.2)$$

17.4.2.1 The nominal concrete breakout strength in tension, $N_{cb}$ of a single anchor or $N_{cbg}$ of a group of anchors, shall not exceed:

(a) For a single anchor

$$N_{cb} = \frac{A_{Nc}}{A_{Nco}} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad (17.4.2.1a)$$

(b) For a group of anchors

$$N_{cbg} = \frac{A_{Nc}}{A_{Nco}} \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad (17.4.2.1b)$$

17.4.3.1 The nominal pullout strength of a single cast-in, post-installed expansion, and post-installed undercut anchor in tension, $N_{pn}$, shall not exceed

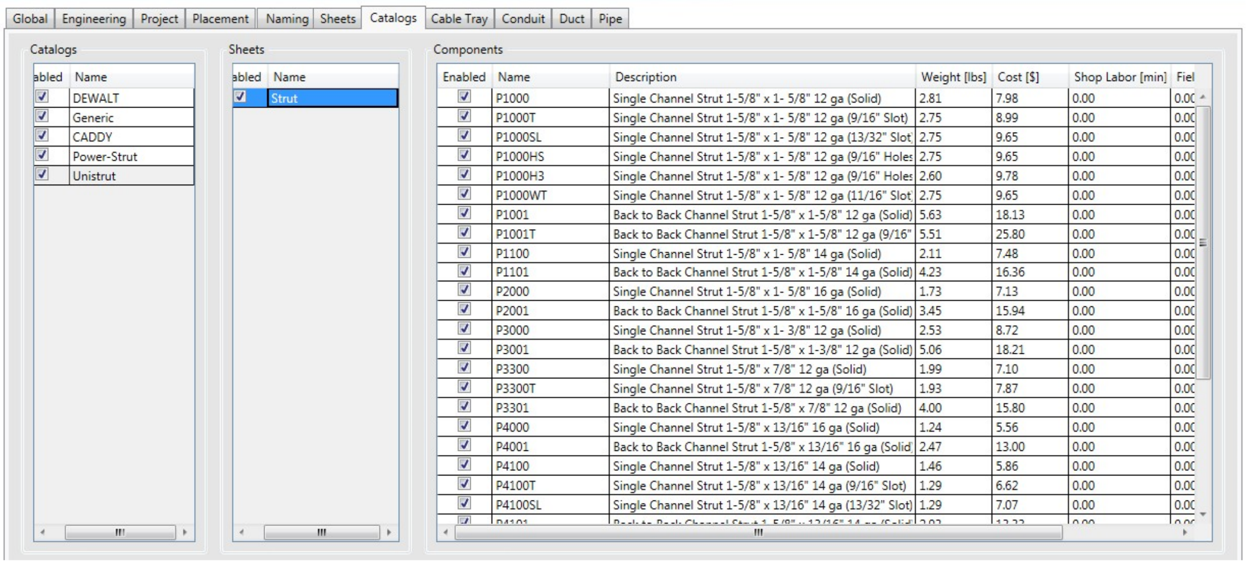
$$N_{pn} = \psi_{c,P} N_p \quad (17.4.3.1)$$

*CODE EQUATIONS TO DETERMINE THE CAPACITY OF A CONCRETE ANCHOR*

As another example, the engineering analysis and calculation needed to determine the bending stress and deflection on a piece of strut supporting several pipes is even more complicated. This problem lends itself to an automation process where these types of calculations can be directly programmed in to the BIM workflow – which is achieved with the HangerWorks plugin. Engineering calculations, building code requirements, trade rules and common practice rules are all built in to HangerWorks to select and size these components.

## Placement of Hangers and Bracing

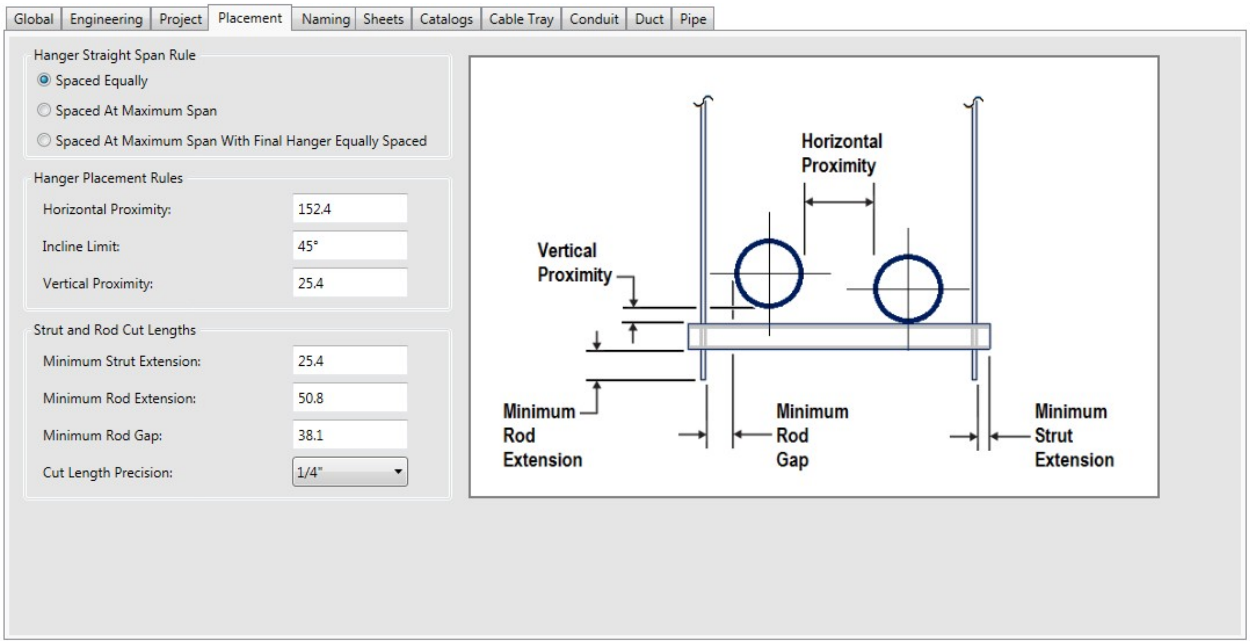
With analysis of loading conditions and design calculations available within Revit, HangerWorks can automatically and efficiently design and place hangers and seismic bracing. In order to do this, these components must be assembled from actual manufacturer content including accurate dimensional information, engineering properties and cost information. HangerWorks includes a large library of hardware from multiple suppliers which can be selected by the designer. The designer can select which types of components or which hardware manufacturers they would like to include in the hanger and bracing calculations. For example, only 3/8" and 1/2" rod sizes can be selected to ensure all hangers are built from 1/2" diameter threaded rods.




*HARDWARE LIBRARY*

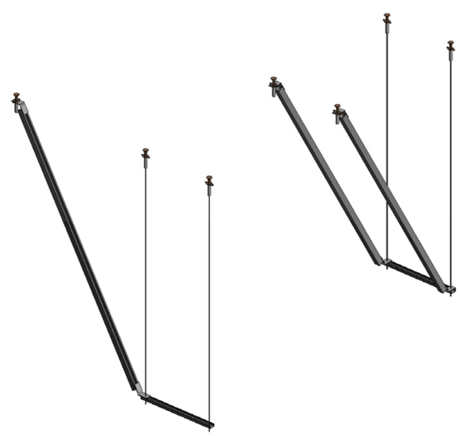
A further benefit of using proprietary components is that the user can compare the cost of various systems by creating accurate Bill of Materials for various systems and perform true cost-benefit analysis on certain design selections. HangerWorks includes input fields for individual cost content for the components, installation times and both shop and field labor rates. This will allow the designer to answer questions such as: "which assemblies should I fabricate in the shop vs. fabrication in the field?" or "does it make more sense to hang this system with 3/8" threaded rod at 6 ft. on center, or 1/2" threaded rod at 8 ft. on center?"

Before hangers and braces are placed, the designer sets rules, tolerances and preferences for hangers and braces. HangerWorks then places hangers in the model on the selected distributed systems following the engineering guidelines, code requirements and settings setup in the program – using the most cost efficient option from the component types selected by the designer.




*EXAMPLE OF SETTINGS DIALOGUE*

For the case of seismic bracing, the designer runs the brace function to insert transverse and longitudinal braces to the existing hanger points as required by the building code. HangerWorks includes functionality to use both rigid and cable bracing.



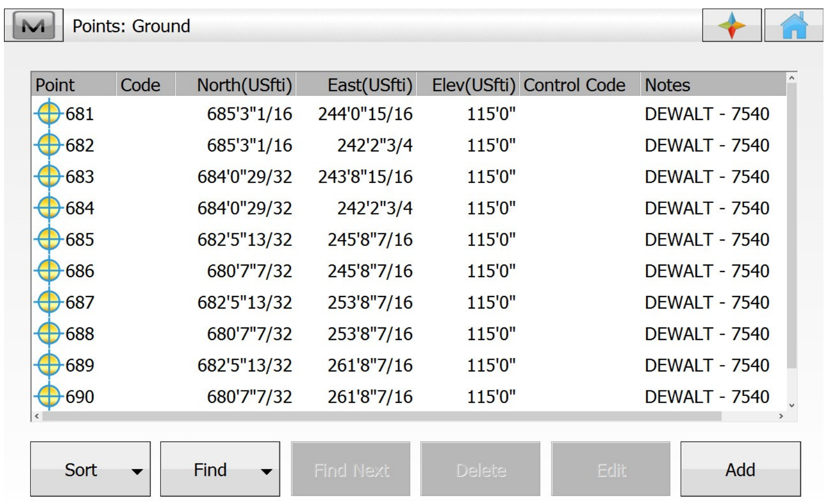
*TRANSVERSE AND LONGITUDINAL BRACES*

As with the real time hanger load calculations, the seismic bracing calculations run real-time as well. This allows the braces to be moved and adjusted during coordination meetings or for design changes, while still validating the calculations meet building code requirements. By modeling the braces up front in the design process, and the ability to constantly validate the MEP system is braced properly through the coordination process with these “on the fly” calculations, HangerWorks gives the user significant benefits in seismic conditions vs. traditional workflows.

## Output: Schedules, BOMs and Calculations

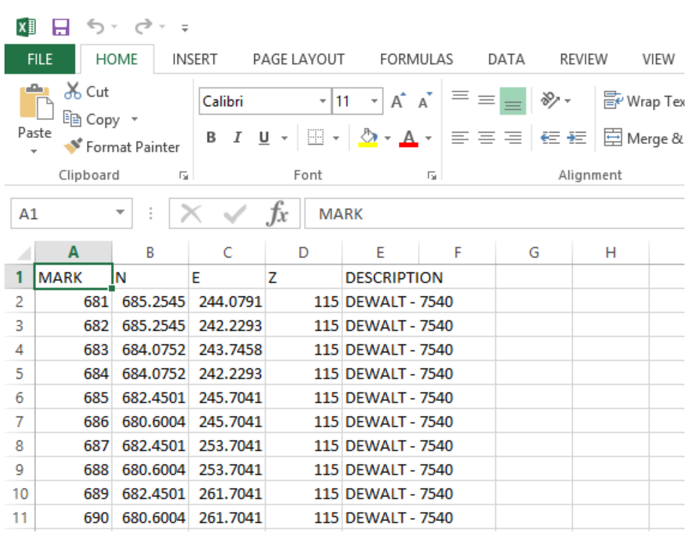
With hangers and braces built with actual hardware content with real parametric data placed properly in the model, the designer can begin to take advantage of many of benefits of BIM both in the office and in the field. DEWALT HangerWorks has several types of built-in outputs many of which coordinate directly with Revit's native capabilities and schedules.

Points can be generated for each hanger rod instance and saved as various file types for field layout of hangers with different types of total stations.




| Point | Code | North(USfti) | East(USfti) | Elev(USfti) | Control Code | Notes |
|---|---|---|---|---|---|---|
| 681 | | 685'3"1/16 | 244'0"15/16 | 115'0" | | DEWALT - 7540 |
| 682 | | 685'3"1/16 | 242'2"3/4 | 115'0" | | DEWALT - 7540 |
| 683 | | 684'0"29/32 | 243'8"15/16 | 115'0" | | DEWALT - 7540 |
| 684 | | 684'0"29/32 | 242'2"3/4 | 115'0" | | DEWALT - 7540 |
| 685 | | 682'5"13/32 | 245'8"7/16 | 115'0" | | DEWALT - 7540 |
| 686 | | 680'7"7/32 | 245'8"7/16 | 115'0" | | DEWALT - 7540 |
| 687 | | 682'5"13/32 | 253'8"7/16 | 115'0" | | DEWALT - 7540 |
| 688 | | 680'7"7/32 | 253'8"7/16 | 115'0" | | DEWALT - 7540 |
| 689 | | 682'5"13/32 | 261'8"7/16 | 115'0" | | DEWALT - 7540 |
| 690 | | 680'7"7/32 | 261'8"7/16 | 115'0" | | DEWALT - 7540 |

*POINTS FOR TOTAL STATION LAYOUT*



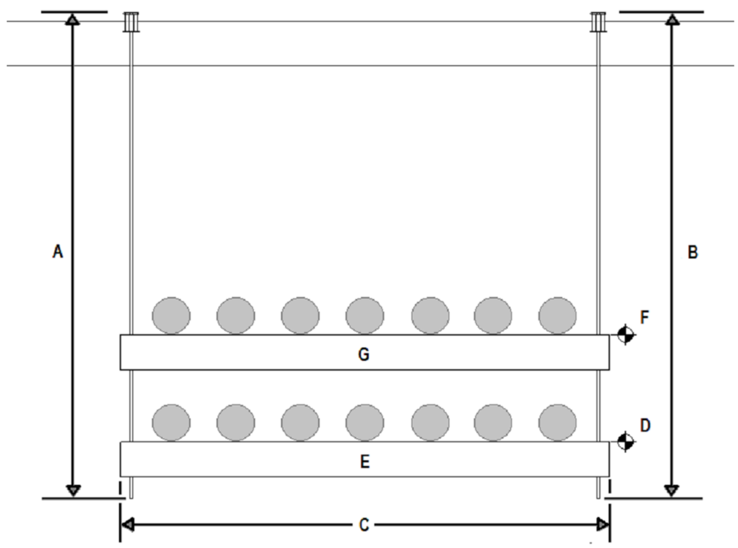
| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | MARK | N | E | Z | DESCRIPTION |
| 2 | 681 | 685.2545 | 244.0791 | 115 | DEWALT - 7540 |
| 3 | 682 | 685.2545 | 242.2293 | 115 | DEWALT - 7540 |
| 4 | 683 | 684.0752 | 243.7458 | 115 | DEWALT - 7540 |
| 5 | 684 | 684.0752 | 242.2293 | 115 | DEWALT - 7540 |
| 6 | 685 | 682.4501 | 245.7041 | 115 | DEWALT - 7540 |
| 7 | 686 | 680.6004 | 245.7041 | 115 | DEWALT - 7540 |
| 8 | 687 | 682.4501 | 253.7041 | 115 | DEWALT - 7540 |
| 9 | 688 | 680.6004 | 253.7041 | 115 | DEWALT - 7540 |
| 10 | 689 | 682.4501 | 261.7041 | 115 | DEWALT - 7540 |
| 11 | 690 | 680.6004 | 261.7041 | 115 | DEWALT - 7540 |

*CSV FILE OUTPUT*

A complete Bill of Materials can be quickly created for all hanger and bracing components for simplified ordering and planning of material deliveries. Spool sheets are auto generated for prefabrication containing lists of all components and cut lengths which can be sent straight the fabrication shop.

DHW-TPZ2-01

| Count | Prefab ID | Upper Attachment Side 1 | Upper Attachment Side 2 | [A] Cut Length Rod 1 | Upright Support Type Side 1 | [B] Cut Length Rod 2 | Uprigh |
|---|---|---|---|---|---|---|---|
| 26 | TPZ2-01-001 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 6' - 10 13/16" | Threaded Rod : Rod - Generic - 1/4 - 20 | 6' - 10 13/16" | Threaded R |

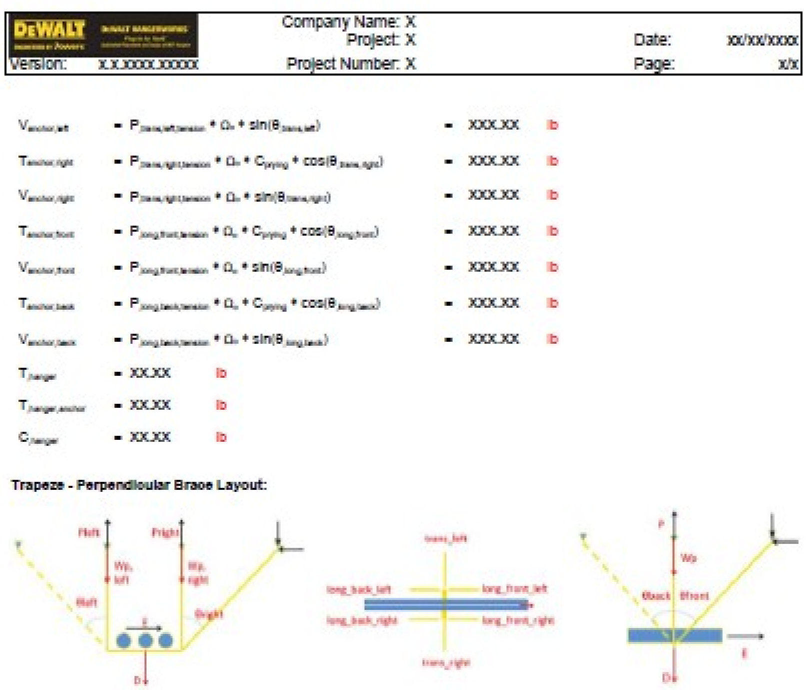



*SPOOL SHEET FOR PRE-FABRICATION*

Engineering calculations can be output in several formats: a tabular format which can be used to export all point loads for example, as well as with full calculation output which engineers are familiar with reviewing for submittals.

| DEWALT Engineering | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Prefab ID | Mark | Upper Attachment Side 1 | Upper Attachment Side 2 | Gravity Load | Anchor 1 Tension | Support 1 Compression | Support 1 Tension | Anchor 2 Tension | Support 2 Compression | Support 2 Tension |
| TPZ2-02-001 | 0683 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 114.92 lbf | 42.19 lbf | 0.00 lbf | 42.19 lbf | 63.85 lbf | 0.00 lbf | 63.85 lbf |
| TPZ2-01-001 | 0697 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 284.67 lbf | 145.20 lbf | 0.00 lbf | 145.20 lbf | 130.50 lbf | 0.00 lbf | 130.50 lbf |
| TPZ2-01-001 | 0699 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 291.02 lbf | 148.38 lbf | 0.00 lbf | 148.38 lbf | 133.68 lbf | 0.00 lbf | 133.68 lbf |
| TPZ2-01-001 | 0695 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 313.04 lbf | 152.04 lbf | 0.00 lbf | 152.04 lbf | 152.04 lbf | 0.00 lbf | 152.04 lbf |
| TPZ2-01-001 | 0701 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 325.75 lbf | 158.39 lbf | 0.00 lbf | 158.39 lbf | 158.39 lbf | 0.00 lbf | 158.39 lbf |
| TPZ2-01-001 | 0731 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 347.19 lbf | 169.11 lbf | 0.00 lbf | 169.11 lbf | 169.11 lbf | 0.00 lbf | 169.11 lbf |
| TPZ2-01-001 | 0721 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 377.35 lbf | 176.84 lbf | 0.00 lbf | 176.84 lbf | 191.54 lbf | 0.00 lbf | 191.54 lbf |
| TPZ2-01-001 | 0723 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 377.35 lbf | 176.84 lbf | 0.00 lbf | 176.84 lbf | 191.54 lbf | 0.00 lbf | 191.54 lbf |
| TPZ2-01-001 | 0685 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 391.78 lbf | 187.31 lbf | 0.00 lbf | 187.31 lbf | 195.50 lbf | 0.00 lbf | 195.50 lbf |
| TPZ2-01-001 | 0693 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 405.73 lbf | 198.38 lbf | 0.00 lbf | 198.38 lbf | 198.38 lbf | 0.00 lbf | 198.38 lbf |
| TPZ2-01-001 | 0703 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 412.08 lbf | 201.56 lbf | 0.00 lbf | 201.56 lbf | 201.56 lbf | 0.00 lbf | 201.56 lbf |
| TPZ2-01-001 | 0681 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 422.34 lbf | 214.52 lbf | 0.00 lbf | 214.52 lbf | 198.85 lbf | 0.00 lbf | 198.85 lbf |
| TPZ2-01-001 | 0729 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 422.80 lbf | 206.92 lbf | 0.00 lbf | 206.92 lbf | 206.92 lbf | 0.00 lbf | 206.92 lbf |
| TPZ2-01-001 | 0687 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0689 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0691 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0705 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0707 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0709 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0711 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0713 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0715 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0717 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0719 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0725 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0727 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 498.41 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf | 244.72 lbf | 0.00 lbf | 244.72 lbf |
| TPZ2-01-001 | 0733 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | Dewalt-Powers Bang It : Anchor - DEWALT - 7540 | 577.29 lbf | 284.16 lbf | 0.00 lbf | 284.16 lbf | 284.16 lbf | 0.00 lbf | 284.16 lbf |

*EXAMPLE OF TABULAR OUTPUT OF POINT LOADS*




*EXAMPLE OF FULL ENGINEERING OUTPUT*

## Conclusion

MEP Contractors can benefit greatly from using BIM to design common distributed systems such as piping, duct, conduit and cable tray. The hangers and braces required to support these systems have been a pain-point in the modeling and fabrication workflow due to the myriad of rules, codes and calculations required properly select and design these assemblies. This significantly reduces the benefits of using BIM and with inefficiencies and added cost.

DEWALT HangerWorks is designed to help improve this process by adding functionality into Revit specifically for the design and selection of hanger and brace assemblies to help the designer, the engineer, the fabrication process and the field installation.

While DEWALT has worked closely with MEP contractors such as MMC Contractors that are pushing the limits on the future of construction, they are aware that a good piece of software is never truly finished, and never the perfect solution for everyone. DEWALT is fully committed to working with the future users of HangerWorks on continued development of the features and functionality and looks forward to improving future BIM workflows.

DEWALT®
ENGINEERED BY Powers™

DEWALT HANGERWORKS™
Plug-In for Revit™
Automated Placement and Design of MEP Hangers