AUTODESK UNIVERSITY

CS502129

Assemble + Power BI
Developing a Powerful and Practical Model-Checking tool

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Learning Objectives

- Learn how to create a workflow to visualize design model content using Autodesk Assemble and Power BI.
- Learn how to validate design model content to reduce risk and save time and money.
- Learn about the features of Autodesk Assemble for design model validation.
- Learn about engaging with a wider project team through powerful data visualizations.

Description

Mott MacDonald is delivering a major infrastructure project involving the production of many design models with strict attribute information requirements. The challenge? How could the BIM and engineering teams ensure that deliverables were compliant, consistent and the necessary checks were undertaken before each submission to the client? We've used Autodesk Assemble and Microsoft Power BI to develop an innovative and powerful solution to interrogate and validate the content of our design models, improving the QA/QC process for our deliverables, and ensuring delivery was right first time, on time. In this Technical Instruction, you'll learn the steps needed to adopt this workflow on your project to improve your data-checking process, have increased confidence in your deliverables, reduce risk, and save money.

Speakers

Paul Briedis - Digital Lead

Working with Mott MacDonald for 18 years, originally as Highways engineer and last 6 years as Digital Lead supporting the delivery of Transportation projects. Extensive experience working on large-scale, multi-discipline projects.

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Fouad Mulla - Information Manager

Information and Cyber Security professional with +10 years of experience in the software and engineering industry. Worked with many multinational companies such as Graphisoft. Architect and Solution Designer, passionate about cloud and emerging technologies.
CASP+, PMP, ITIL and Microsoft Certified: Cybersecurity Architect Expert

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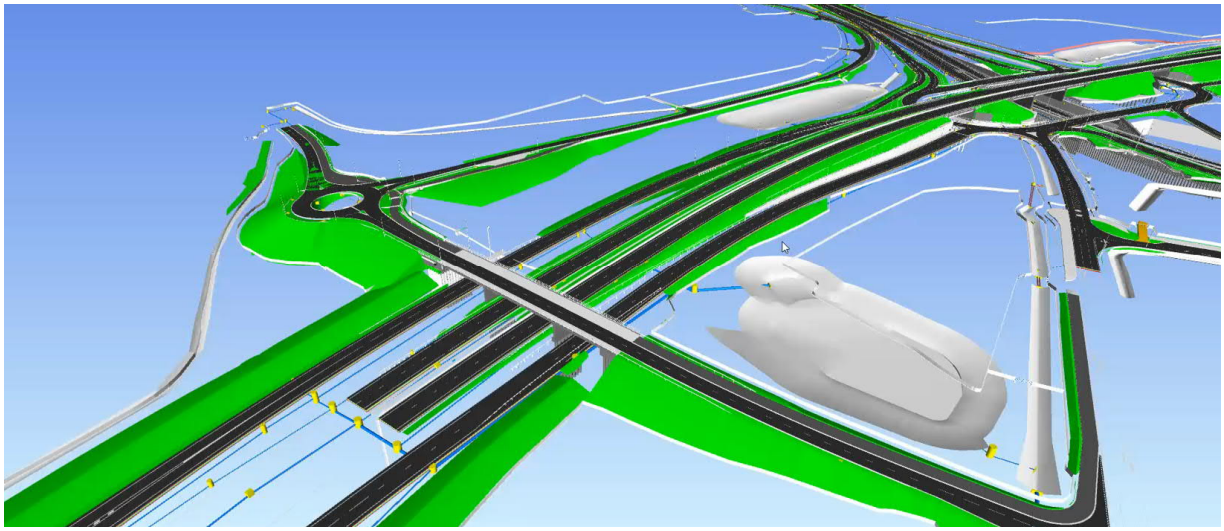
Introduction: The Project

Mott MacDonald recently delivered a major highways project in the UK where we provided the detail design of all engineering services. Our scope included the design, modelling and documentation of approx. 50 Bridge, culvert and geotechnical structures using Autodesk Revit to LoD4 and LoI4

Whilst our large BIM team have experience using Revit for delivering infrastructure projects and have specific Dynamo checking tools, frequent design updates and regular Federated Model submissions meant complying with the extensive model attribute requirements was a major challenge.

Our Client extracted the relevant Asset, Cost, Time and Carbon information from the Federated Model performing their own detailed compliance checks of our deliverables. Due to the downstream impact of any non-compliances within our deliverables, the project team needed to ensure attribute information within our model was compliant from an early stage of the project.



Federated Model snapshot

Acknowledgement to Nathan Hudson – Mott MacDonald Digital Delivery Lead – who has lead the governance, awareness and execution of the project information requirements.

Our Challenges

- **Consistency and compliance** – Ensuring our delivery models comply with the project requirements was a challenge due to the programme and number of the deliverables.
- **Quickly responding to change** – Like most projects, last minute changes or requests need to be expected and allowed for.
- **Connecting engineers and the models** – Ensuring our engineers had visibility of the model content to ensure the design intent was captured.
- **Volume of deliverables** - During peak delivery approximately 50 models submitted to the Client, including 75,000+ attributes that need to be checked and verified.

Rendered image of bridge

What solution did we need?

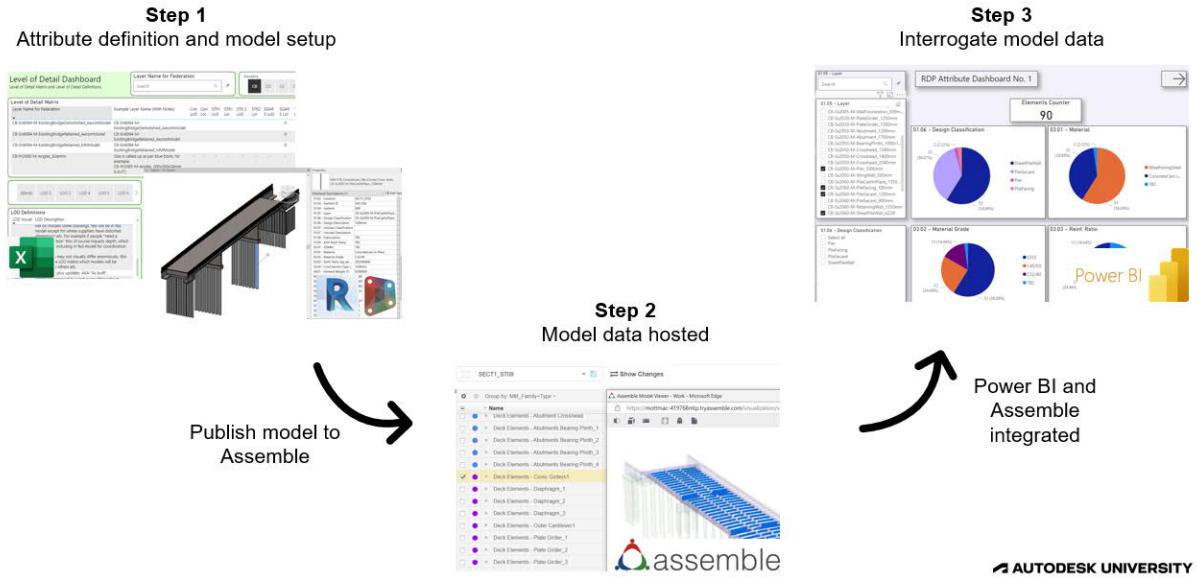
We needed a solution that provided the following:

- Clarity and confidence the models comply with the project requirements
- Assurance the models capture the design intent
- Quick to update and respond to change
- Accessible to all staff and easy to use

The Solution

Following experience learned from infrastructure projects of similar complexity and scale and responding to the Client requirements, the solution we achieved was based on combining two tools: **Autodesk Assemble** and **Power BI**. The high-level, three-step workflow for this solution is outlined below.

- Step 1: Attribute definition and model setup
- Step 2: Publish model data to Assemble
- Step 3: Connect Power BI to Assemble and represent model data in a dashboard



Solution workflow

For this Technical Instruction, we will be focusing on the solution related to assets authored using Autodesk Revit. For those assets authored in Civil 3D, the workflow to define the attributes on the modelled elements uses the *Extended Attribute Data* with models published to Assemble through the Navisworks add-in.

Note: whilst the solution we developed was a powerful tool to assist our team deliver the project and satisfy the information requirements, the rate of development of these and similar tools to interrogate and verify model content is fast paced. As a result the solution for today's project may not be the most suitable for tomorrow. Project Information requirements, project size and complexity, authoring software, digital maturity of the team and clients, programme and budget, are just some factors to consider when developing your solution.

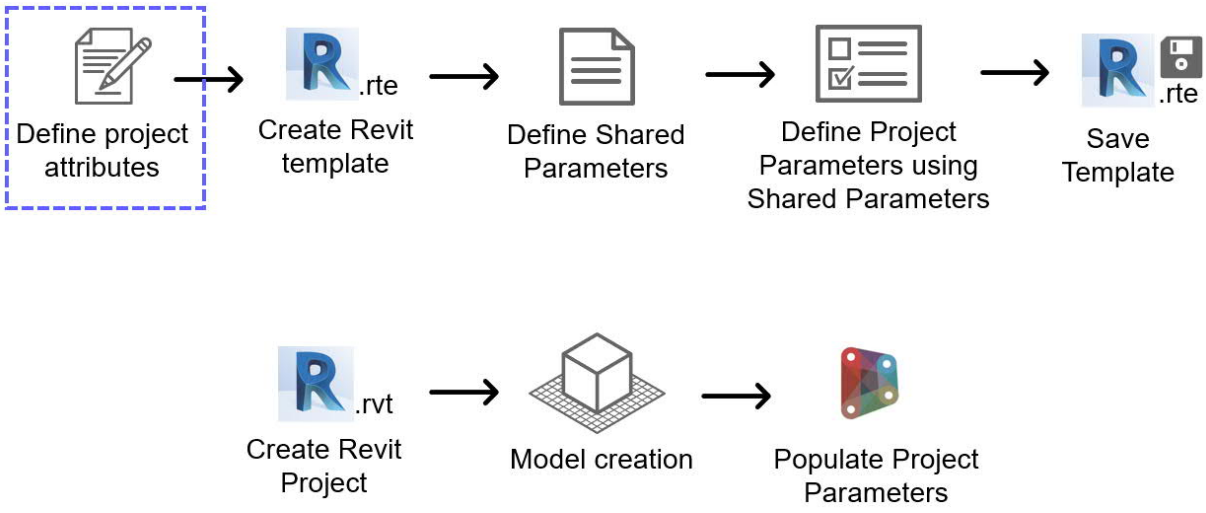
Step 1: Attribute Definition and model setup

This section will show you an example of the attributes we adopted on our project and how they can be defined in Revit.

Key points:

- **It takes time to develop** – We worked with our Client for some time to develop a comprehensive list of attributes required for the project. The attribute requirements for one type of discipline model may not necessarily be suitable for another (e.g. Drainage and gantry asset models).
- **Staff access to guidance and examples** – Whilst a comprehensive list of attributes may be defined, staff need to quickly and easily find how to define these in their models.

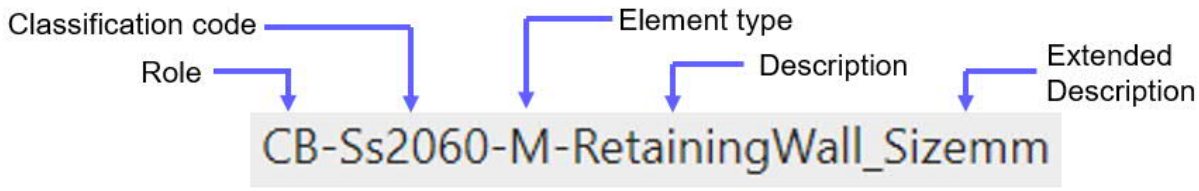
The workflow defining the attributes through to setting up the model is summarized below:



Attribute Definition and Model setup – *Define Project Attributes*

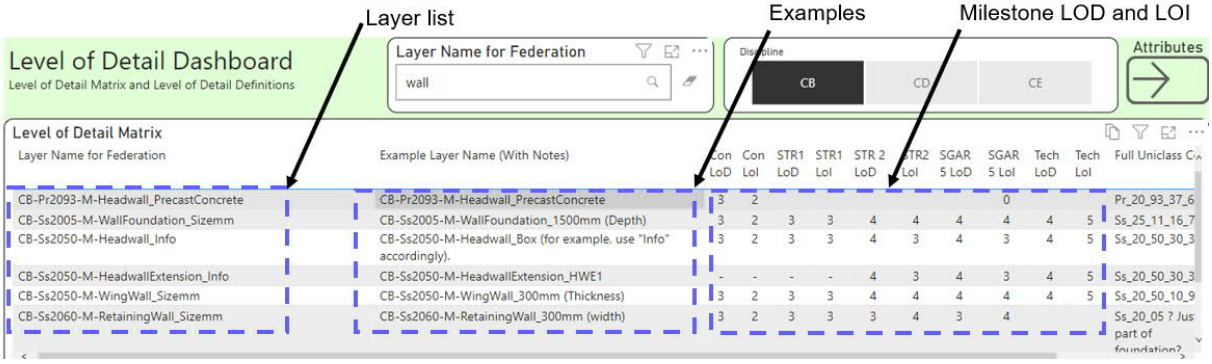
Defining Project Attributes

For our project we adopted the layer convention based on U.K. National Highways GG184 with an example shown below of a *Retaining Wall*. Whilst the structure itself was defined, we still needed to develop a robust list of layers capturing all of the assets expected for each discipline on the project. This process took time and it is suggested you need to account or expect for modification to this list capturing all assets as the project develops and the design matures.



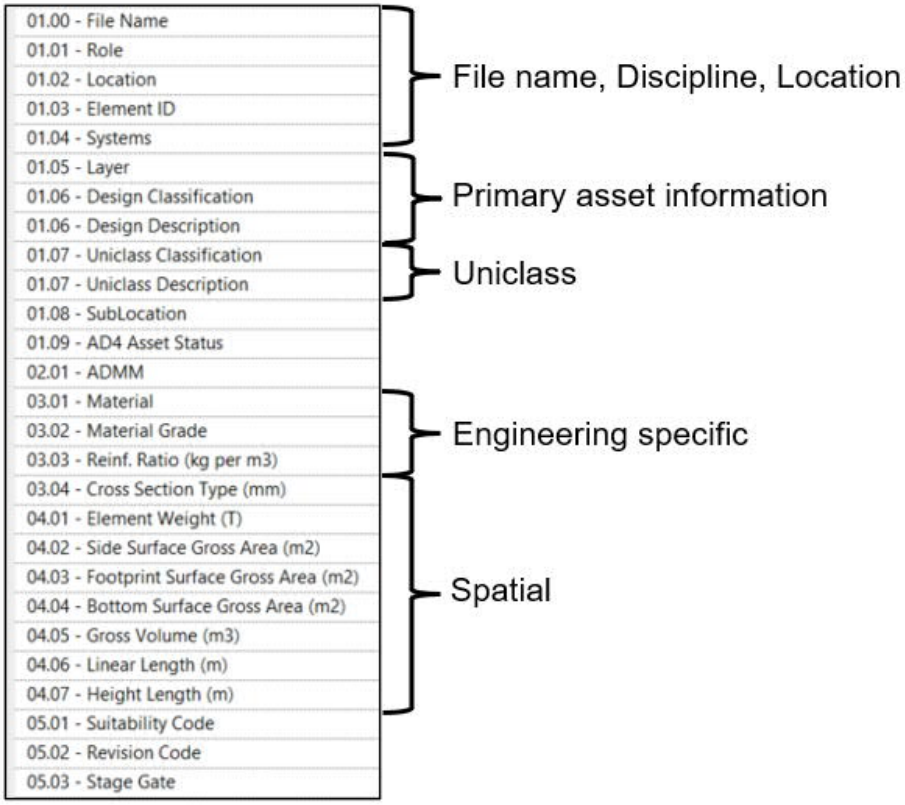
Example layer – Based on UK National Highways GG 184

Our Digital Manager created a simple Power BI dashboard – the '*LOD Matrix'* - to communicate the permitted layers to the project team and included examples and the required LOD and LOI for each element based on the project milestone. As the dashboard was accessible and simple to use, we found it an effective method to communicate this fundamental information to the project team.



LOD Matrix snapshot

The full set of project specific attributes used on the project have been captured in the image below. With some exceptions, modelled assets for all disciplines required the attributes shown.



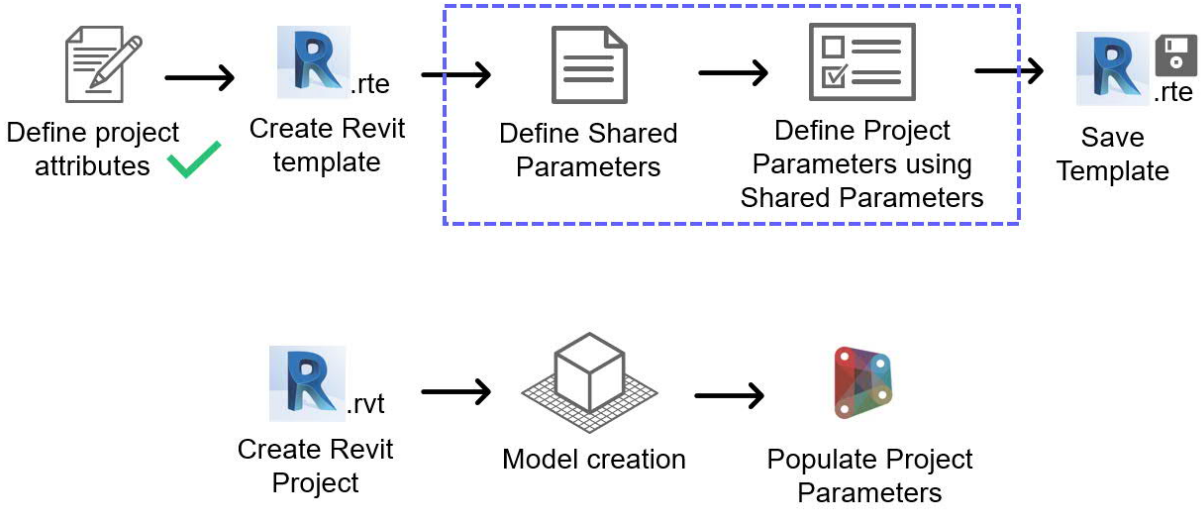
Project specific attributes list for modeled assets

Important to note that the number of attributes that needed to be populated increased as the project developed, and the design matured. During the earlier stages of the programme, it was not possible for the engineering team to define some of the more specific attributes.

Note: It is critical to define and agree which attributes need to be populated by which project milestone. You don't want any last-minute surprises or an un-happy client!

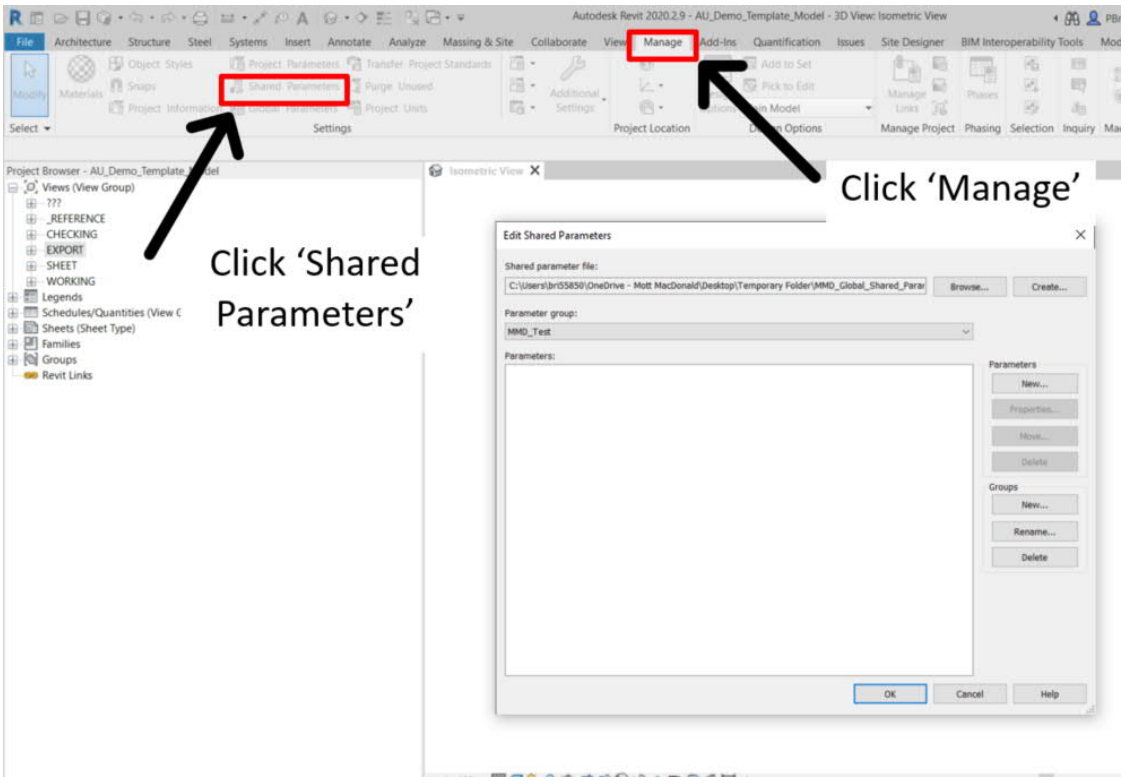
Defining Shared Parameters

Now we have the list attributes required for our project, the next step is defining these within Revit. This section will summarise the main steps to complete this within Revit.

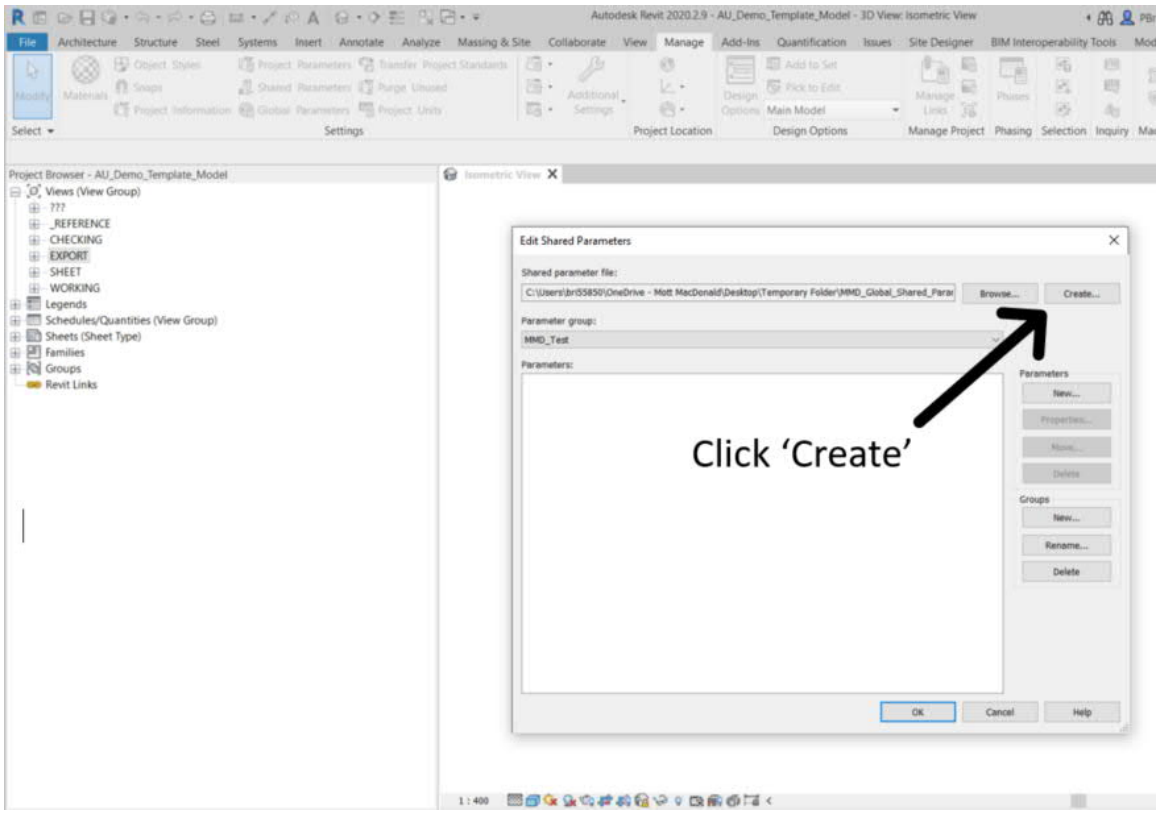


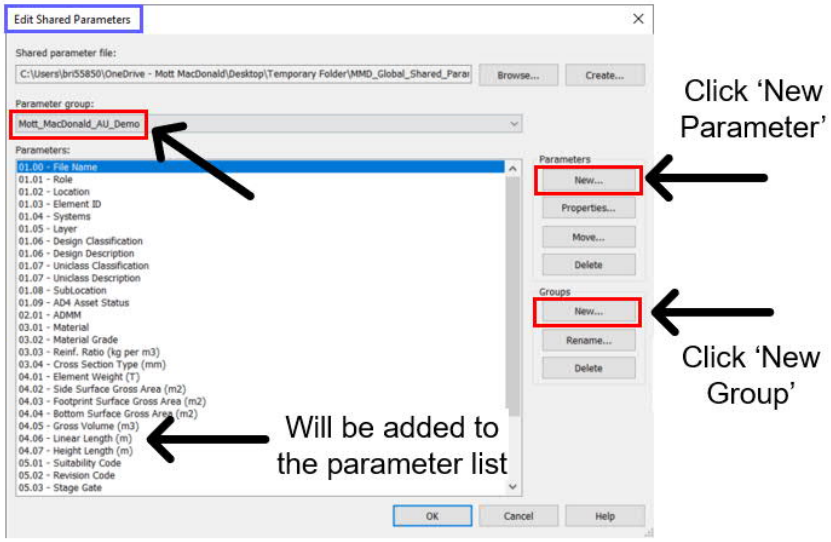
Attribute Definition and Model setup – *Define Shared and Project Parameters*

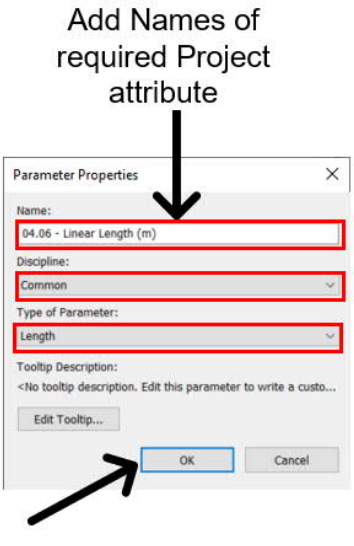
1- Open new Revit Template file.
2- Click "*Manage*" tab in the Ribbon
3- Click "*Shared Parameters*"
4- A window will appear where you can click on "*Create*" to create new Shared Parameters file.



5- Click on "*New*" in the parameters section to add new Shared Parameter.
6- Give it a name, select the discipline and type then hit '*OK*'


Edit Shared Parameters
Shared parameter file:
Browse...
Create...
Parameter group:
MMD_Test
Parameters:
Parameters
New...
Properties...
Move...
Delete
Groups
New...
Rename...
Delete
OK
Cancel
Help
Click 'Create'

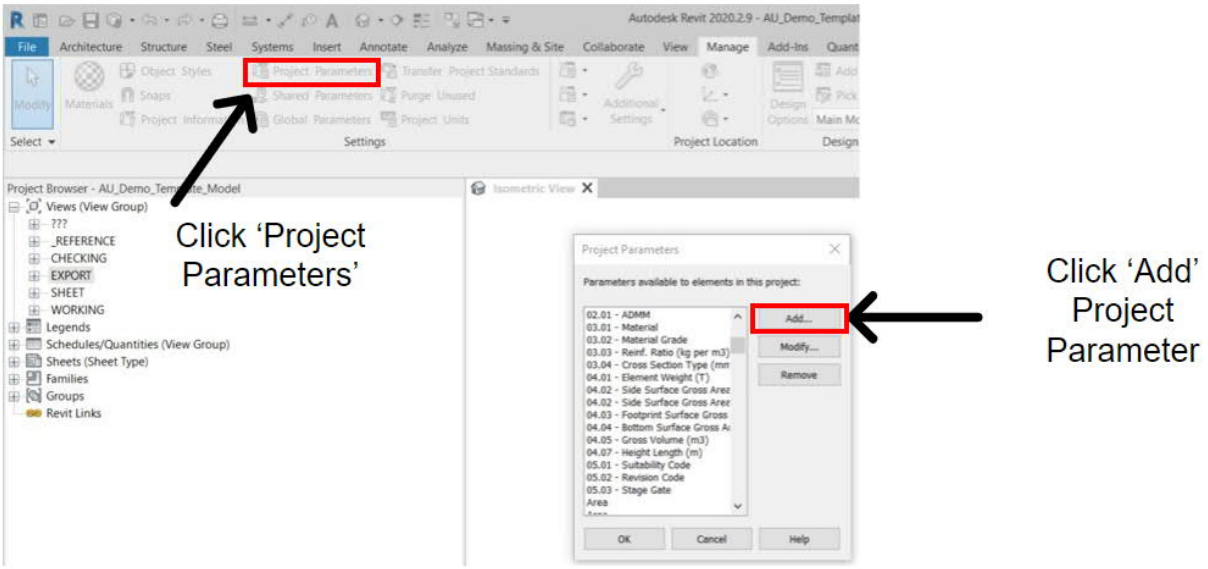

Edit Shared Parameters
Shared parameter file:
Browse...
Create...
Parameter group:
Mott_MacDonald_AU_Demo
Parameters:
01.00 - File Name
01.01 - Role
01.02 - Location
01.03 - Element ID
01.04 - Systems
01.05 - Layer
01.06 - Design Classification
01.06 - Design Description
01.07 - Uniclass Classification
01.07 - Uniclass Description
01.08 - SubLocation
01.09 - AD4 Asset Status
02.01 - ADMM
03.01 - Material
03.02 - Material Grade
03.03 - Reinf. Ratio (kg per m3)
03.04 - Cross Section Type (mm)
04.01 - Element Weight (T)
04.02 - Side Surface Gross Area (m2)
04.03 - Footprint Surface Gross Area (m2)
04.04 - Bottom Surface Gross Area (m2)
04.05 - Gross Volume (m3)
04.06 - Linear Length (m)
04.07 - Height Length (m)
05.01 - Suitability Code
05.02 - Revision Code
05.03 - Stage Gate
Parameters
New...
Properties...
Move...
Delete
Groups
New...
Rename...
Delete
OK
Cancel
Help
Will be added to the parameter list
Click 'New Parameter'
Click 'New Group'


Add Names of required Project attribute
Parameter Properties
Name:
04.06 - Linear Length (m)
Discipline:
Common
Type of Parameter:
Length
Tooltip Description:
<No tooltip description. Edit this parameter to write a custo...
Edit Tooltip...
OK
Cancel

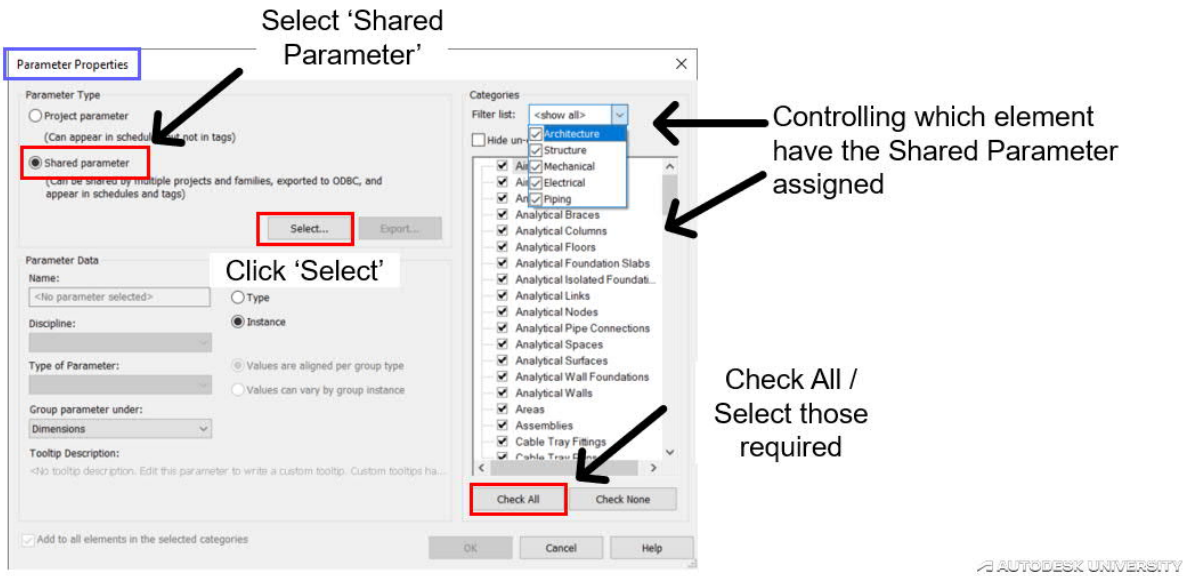
Repeat the above steps until the required number and type of project attributes have been populated as Shared Parameters. When completed we can define these Shared Parameters as Project Parameters which will enable all modelled elements to inherit these attributes.

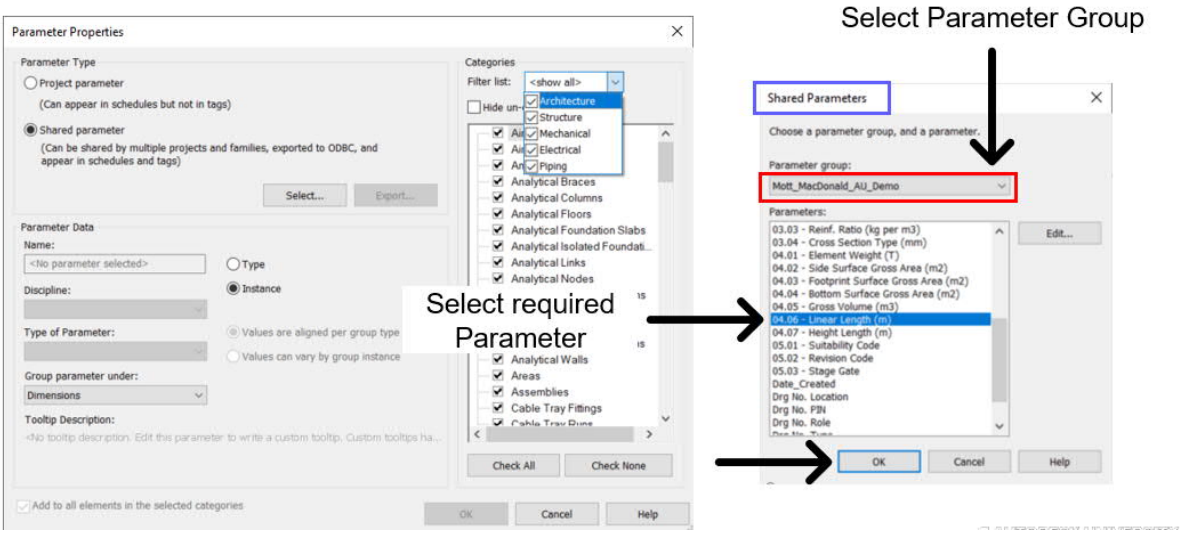
Adding Project Parameters

1- Click on "*Manage*" tab in the Ribbon
2- Click on "*Project Parameters*"
3- Click add from the project parameters window

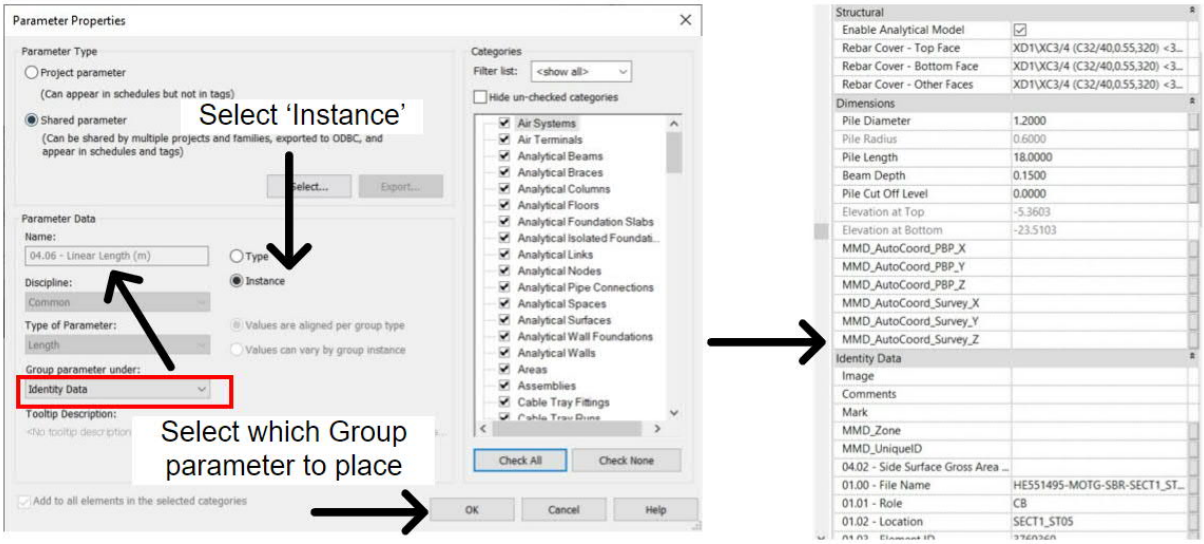


4- Select "*Shared Parameter*" in the Parameter Type properties.
5- Select the parameters you wish to add to your project.
6- You can modify the category to include this parameter in all schedules.



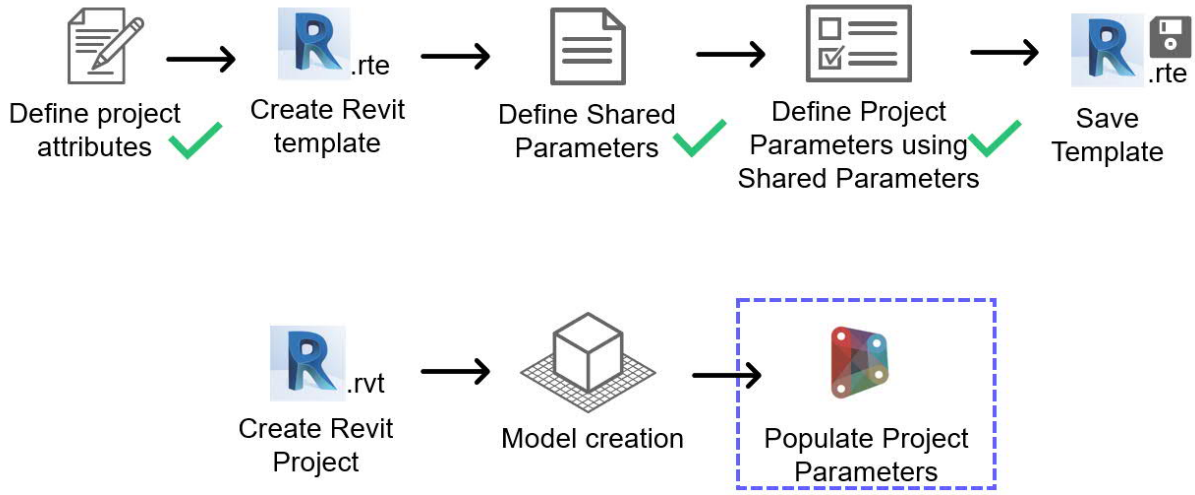


Now all the added parameters will appear in the properties window.


Parameter Properties
Parameter Type
Project parameter
(Can appear in schedules but not in tags)
Shared parameter
(Can be shared by multiple projects and families, exported to ODBC, and appear in schedules and tags)
Select...
Export...
Select 'Instance'
Parameter Data
Name:
04.06 - Linear Length (m)
Type
Instance
Discipline:
Common
Type of Parameter:
Length
Values are aligned per group type
Values can vary by group instance
Group parameter under:
Identity Data
Tooltip Description:
Select which Group parameter to place
Add to all elements in the selected categories
OK
Cancel
Help
Categories
Filter list:
<show all>
Hide un-checked categories
Air Systems
Air Terminals
Analytical Beams
Analytical Braces
Analytical Columns
Analytical Floors
Analytical Foundation Slabs
Analytical Isolated Foundati...
Analytical Links
Analytical Nodes
Analytical Pipe Connections
Analytical Spaces
Analytical Surfaces
Analytical Wall Foundations
Analytical Walls
Areas
Assemblies
Cable Tray Fittings
Check All
Check None
Structural
Enable Analytical Model
Rebar Cover - Top Face
XD1\XC3/4 (C32/40,0.55,320) <3...
Rebar Cover - Bottom Face
XD1\XC3/4 (C32/40,0.55,320) <3...
Rebar Cover - Other Faces
XD1\XC3/4 (C32/40,0.55,320) <3...
Dimensions
Pile Diameter
1.2000
Pile Radius
0.6000
Pile Length
18.0000
Beam Depth
0.1500
Pile Cut Off Level
0.0000
Elevation at Top
-5.3603
Elevation at Bottom
-23.5103
MMD_AutoCoord_PBP_X
MMD_AutoCoord_PBP_Y
MMD_AutoCoord_PBP_Z
MMD_AutoCoord_Survey_X
MMD_AutoCoord_Survey_Y
MMD_AutoCoord_Survey_Z
Identity Data
Image
Comments
Mark
MMD_Zone
MMD_UniqueID
04.02 - Side Surface Gross Area ...
01.00 - File Name
HE551495-MOTG-SBR-SECT1_ST...
01.01 - Role
CB
01.02 - Location
SECT1_ST05

Populating Project Parameters

Once completed, save the Revit Template .rte file as a Revit Project .rvt file. This template will be now the starting point of our Revit project.



Attribute Definition and Model setup – *Populate Project Parameters*

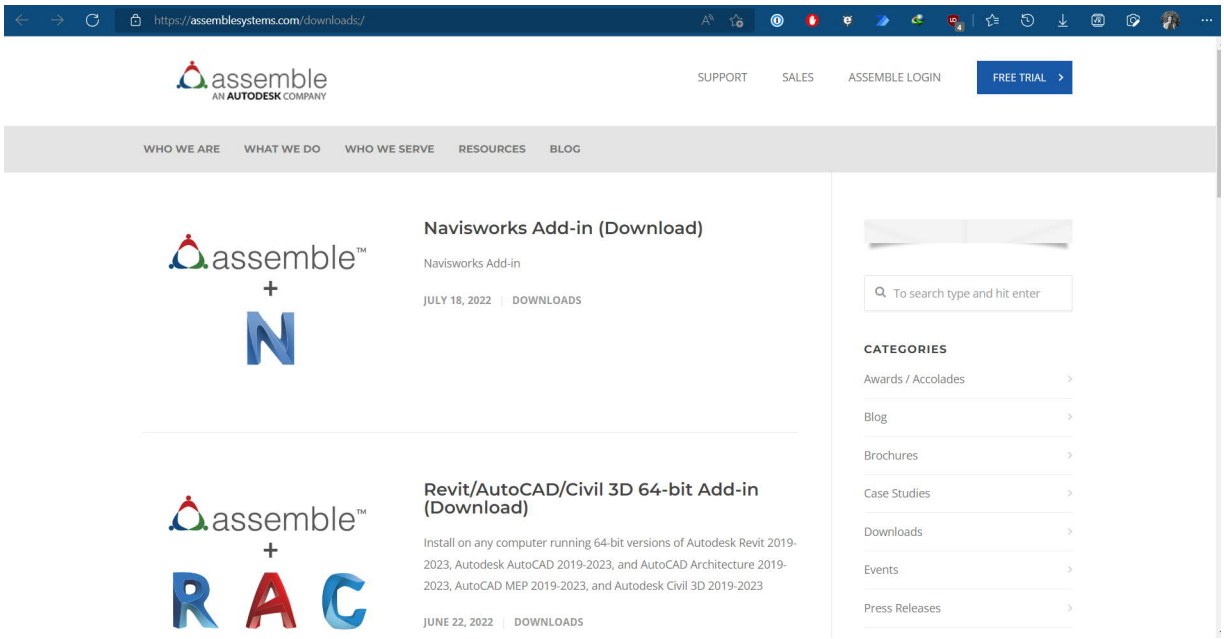
Once the assets have been modelled, we need to map the system attributes to the respective project specific attributes. The attributes were populated using a combination of Dynamo scripts manual input. Due to the relative complexity, guidance on the creation of the Dynamo scripts to complete this task are outside the scope of this Technical Instruction.

Step 2: Publish and hosting model data in Autodesk Assemble

Autodesk Assemble is a cloud-based tool that enables project teams to condition and connect BIM data to design reviews, estimating, change management, scheduling, work-in-place tracking, and more. It has powerful model-based take-off and change management functionality and is integrated with a number of third-party tools.

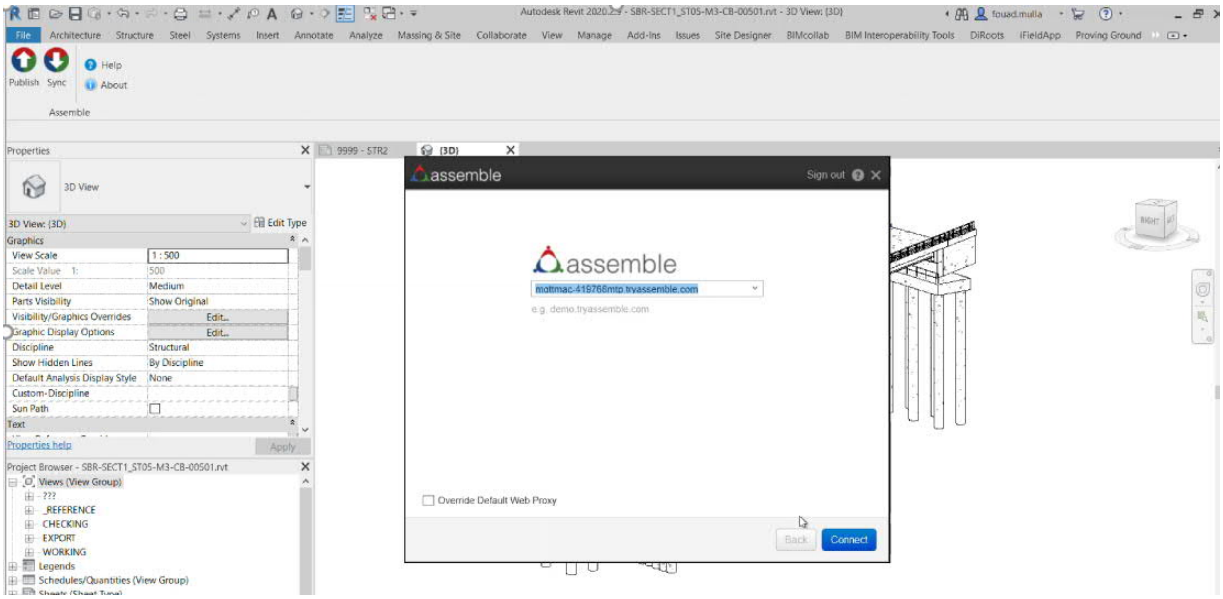
For our solution the design models are published directly to Autodesk Assemble allowing the project data to be interrogated using an array of tools and functions.

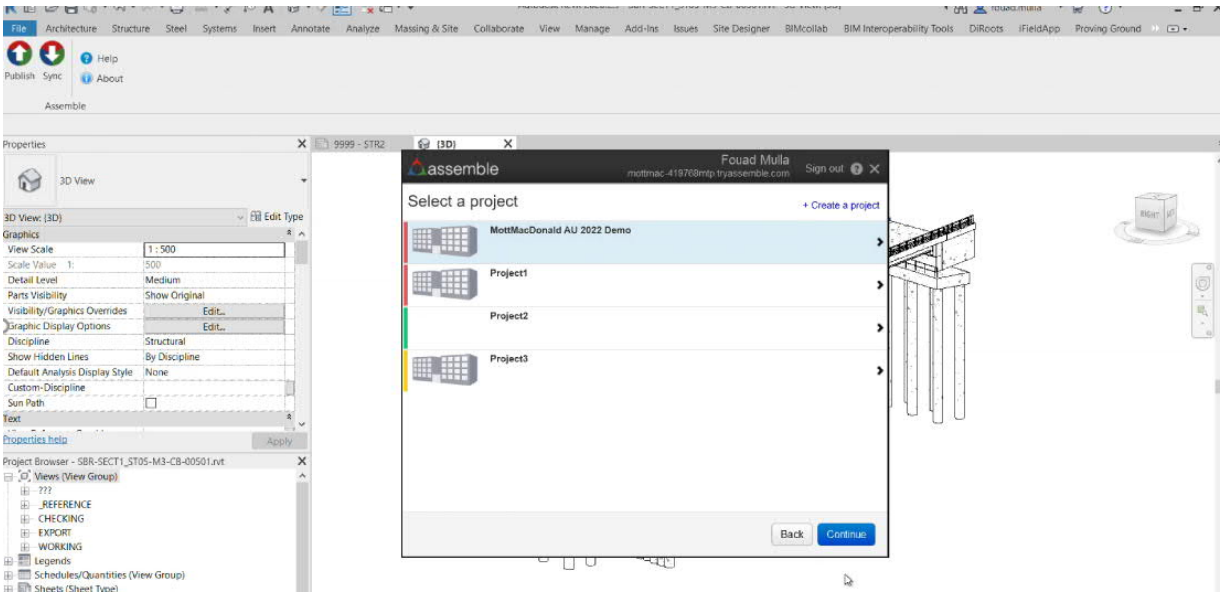
More information about Autodesk Assemble can be found here: https://assemblesystems.com/
Assemble add-ins can be downloaded here: Downloads – Assemble Systems



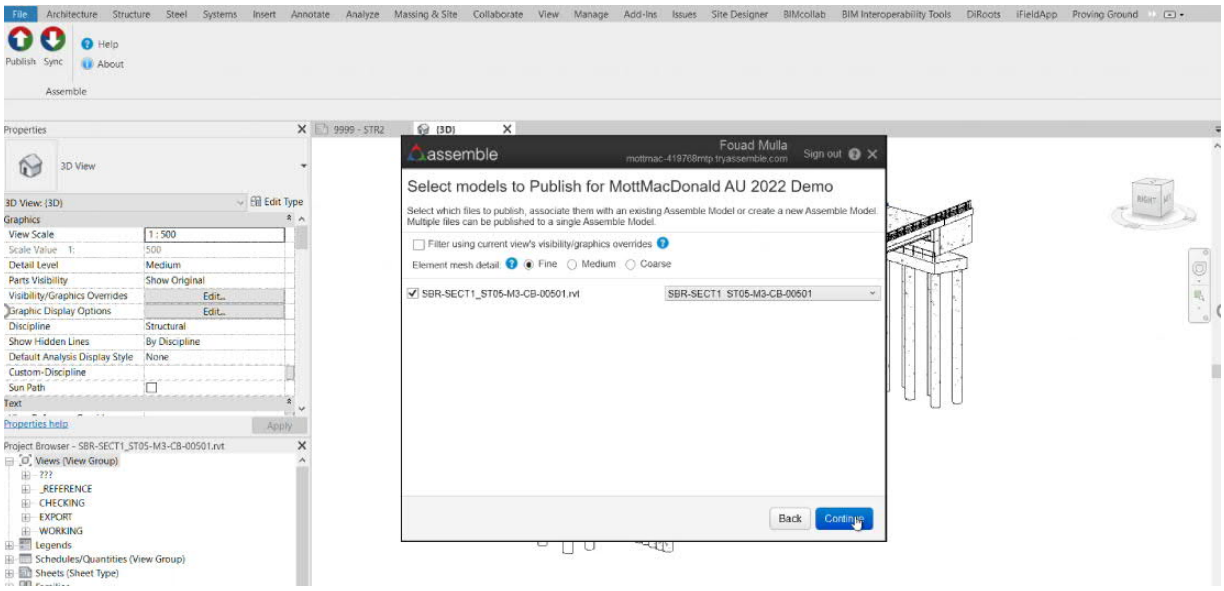
Publishing a model from Revit to Assemble

1- Navigate to the "*Assemble*" plugin ribbon and click "*Publish*"
2- Provide the link to the Assemble server
3- Select your project

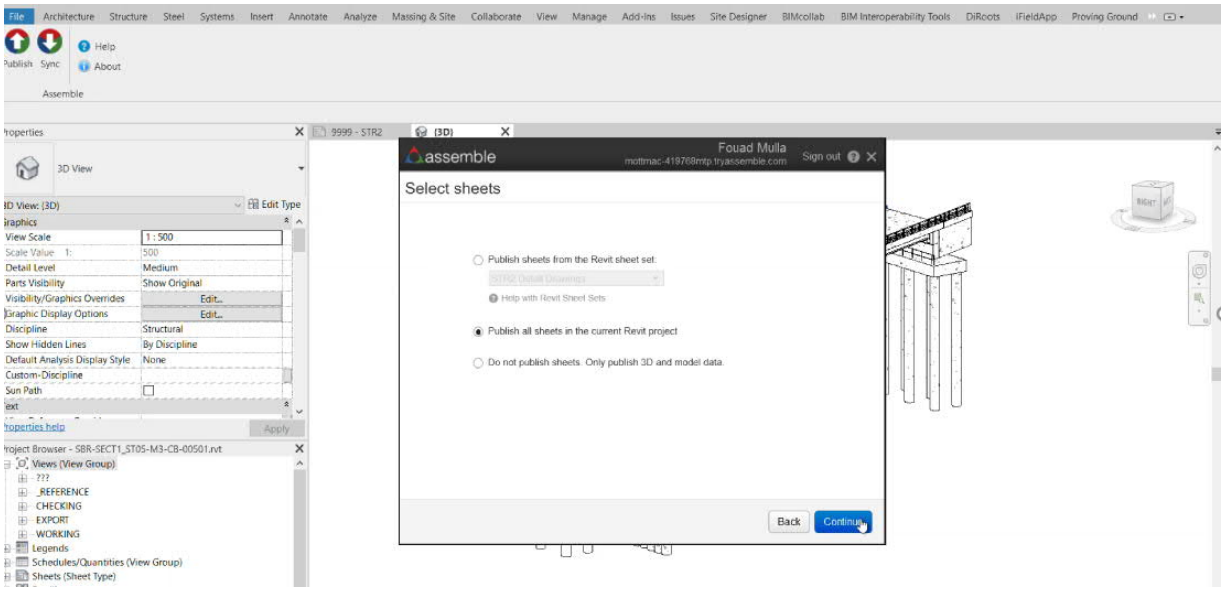




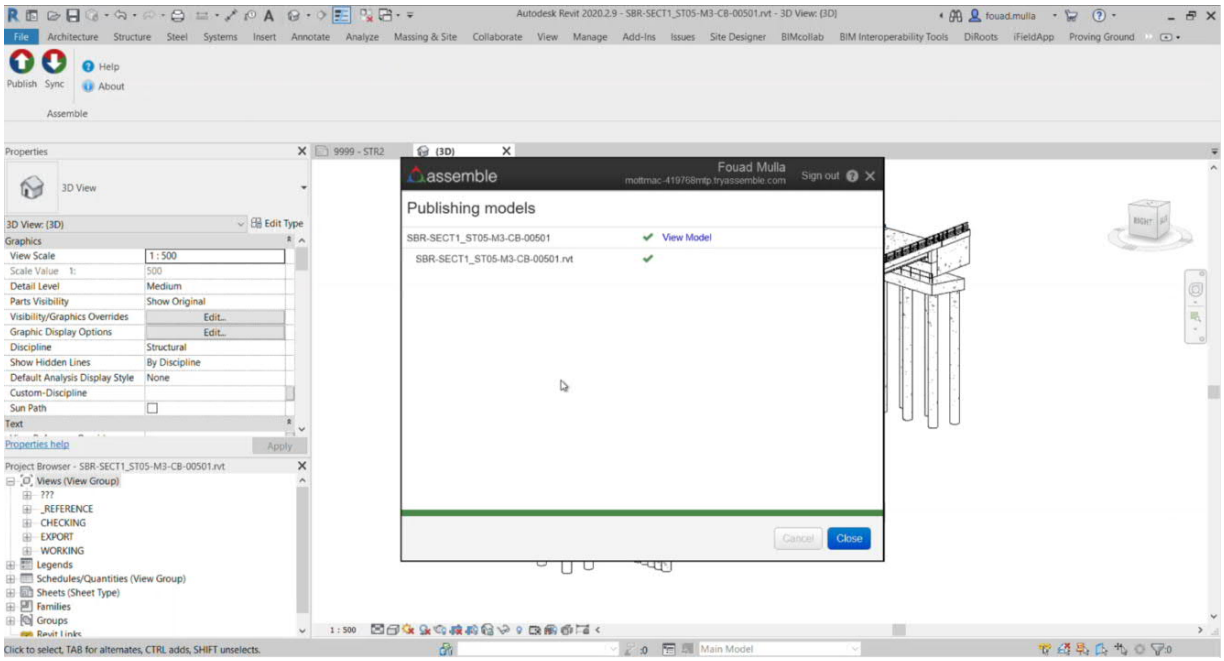
4- Confirm models to be published, the corresponding target Assemble model and the applicable settings.



5- Select sheets to be published to Assemble



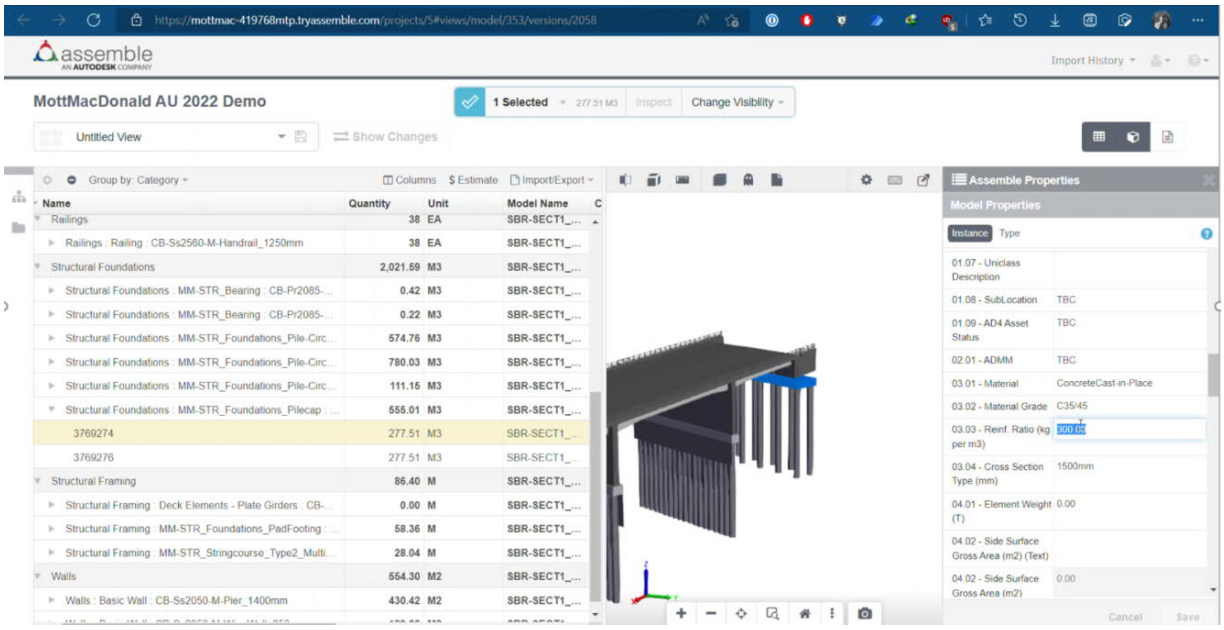
6- Provide applicable Version Name and comment for the model being published.
7- Hit *'Continue'*



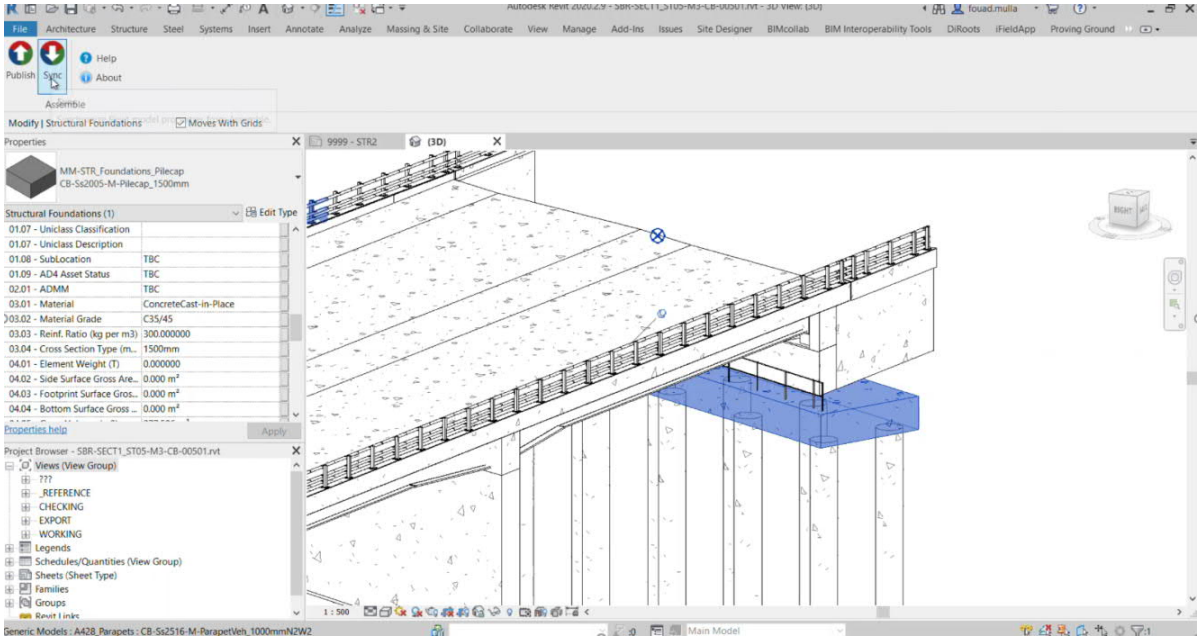
Synchronizing a model from Revit

Once the model is published to Assemble, all attribute information (both project specific and system) is visible, similar to what is visible in the Navisworks Properties. For those attributes which are variable input value (e.g., *Material Grade* or *Reinforcement Ratio*) these values can be defined / updated in Assemble and the value pushed back to the native Revit model.

1- Define attribute information in Assemble as required
2- Click '*Save*'



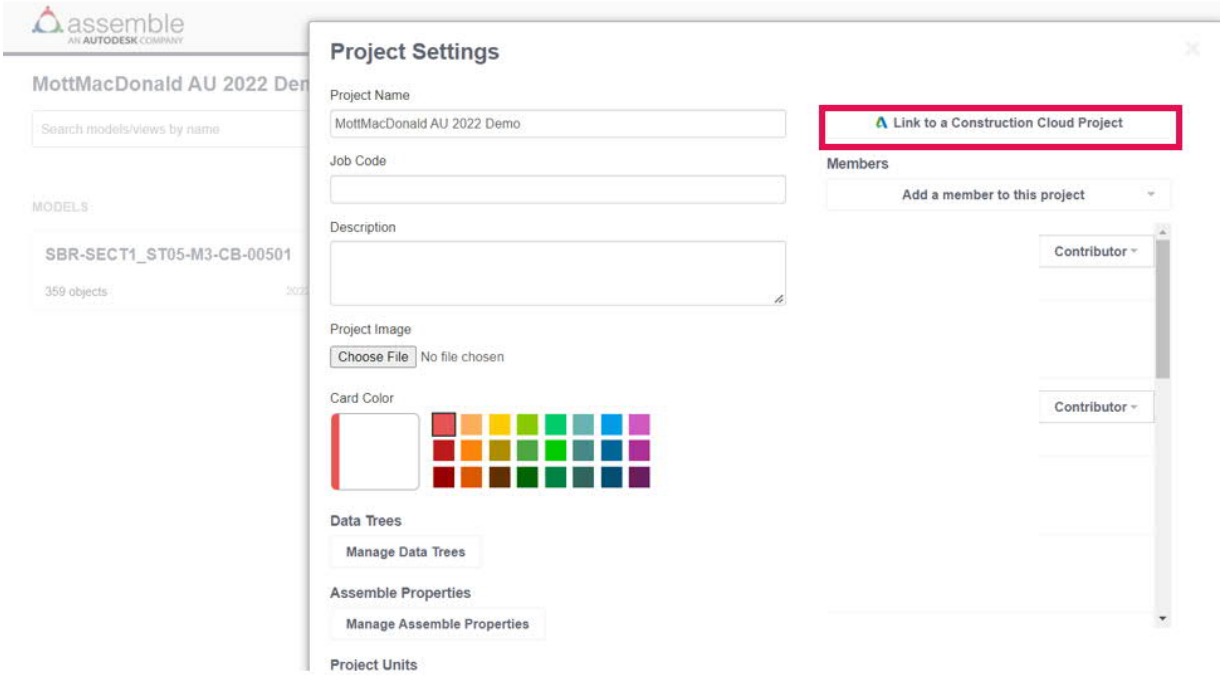
3- Within Revit, navigate to the Assemble Ribbon and click '*Sync*'



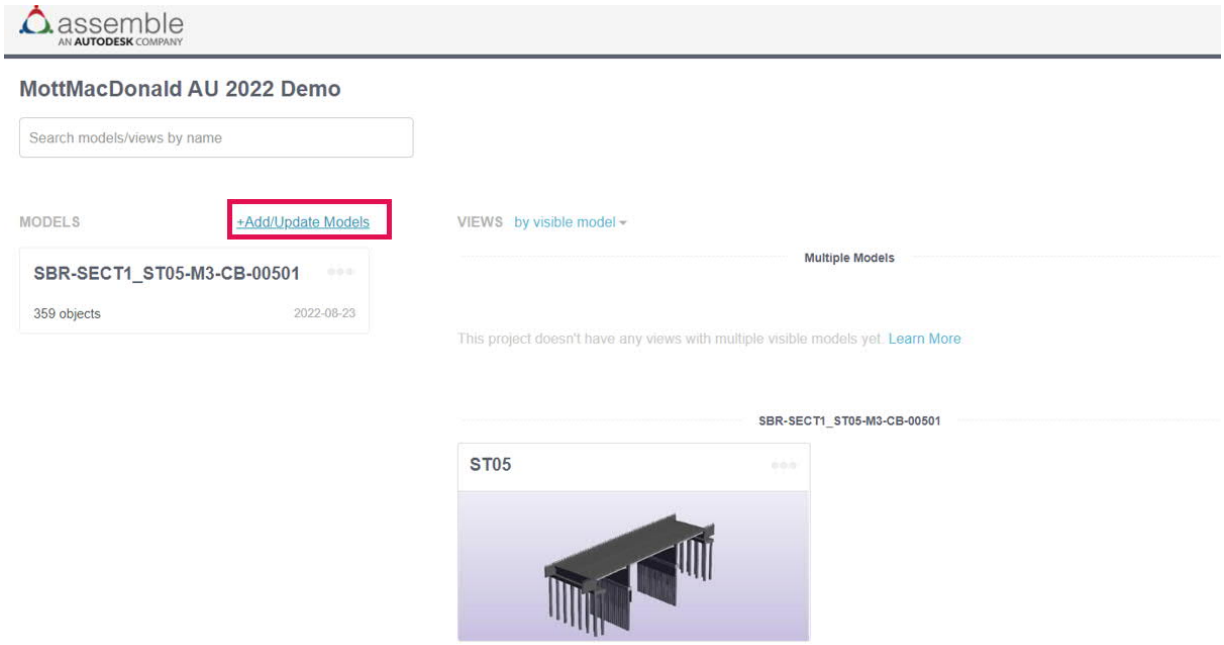
Assemble and BIM 360

Assemble projects can be directly linked to a BIM360 or ACC project enabling the models to be published to Assemble in bulk. This functionality is possible once the applicable BIM360 / ACC project is linked to the Assemble project.

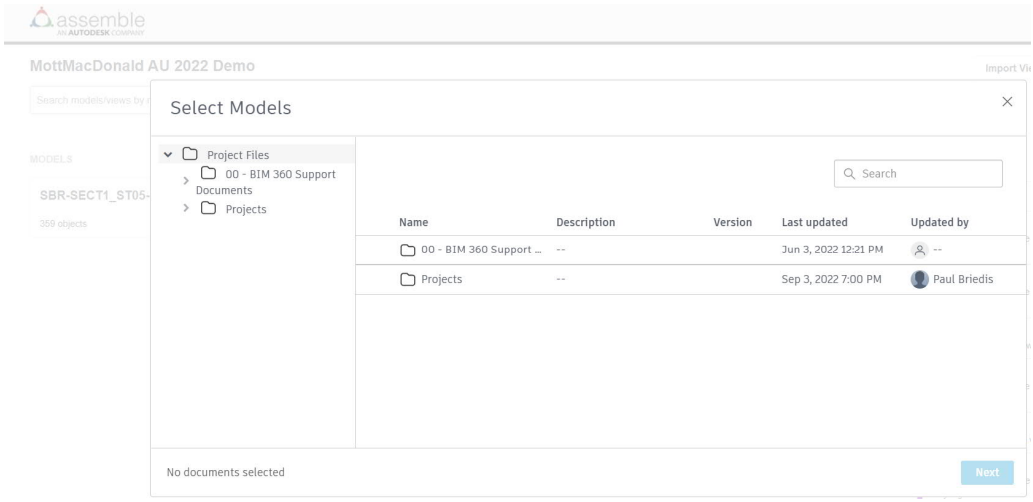
1- Within the Assemble Project Settings page, click 'Link to a *Construction Cloud Project*'
2- Specify the BIM360 or ACC project.



3- On the project home page, click '*+Add/Update Models*'



4- Navigate to the required Revit models and click '*Next*' and '*Publish*'.



Step 3: Setting up the Power BI Dashboard

Now we have our information-rich Revit models published to Assemble, we will set up a Power BI dashboard, connected to the Assemble project, to represent the applicable data.

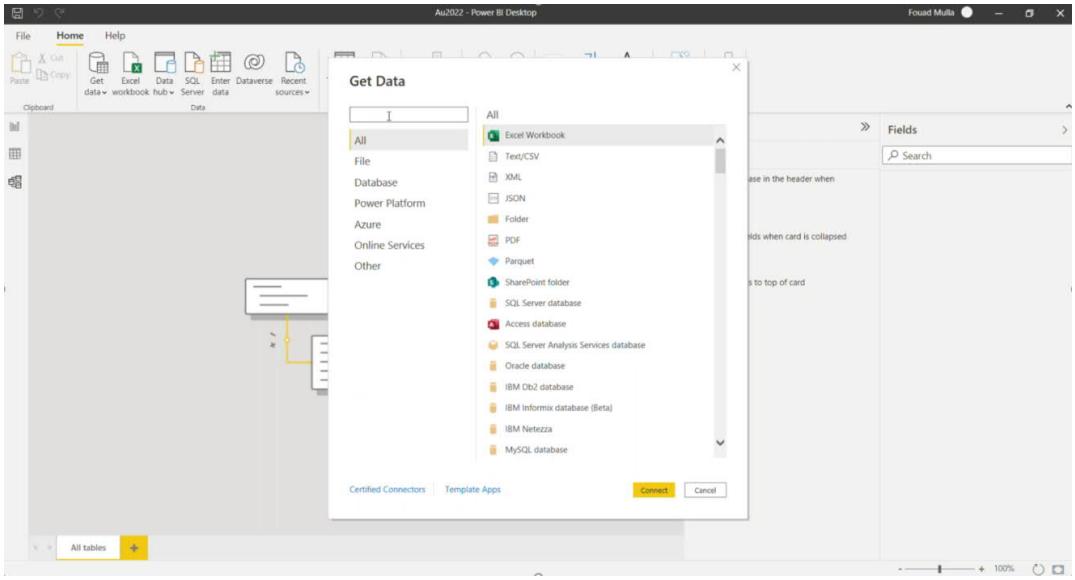
The following steps will be covered in this section:

- **Linking Power BI to Assemble**
- **Data Cleansing**
- **Adding visuals and building our dashboard**
- **Creating a "Health Check"**
- **Publishing the dashboard**

Please refer to the recording of this Technical Instruction for step-by-step details of the following steps.

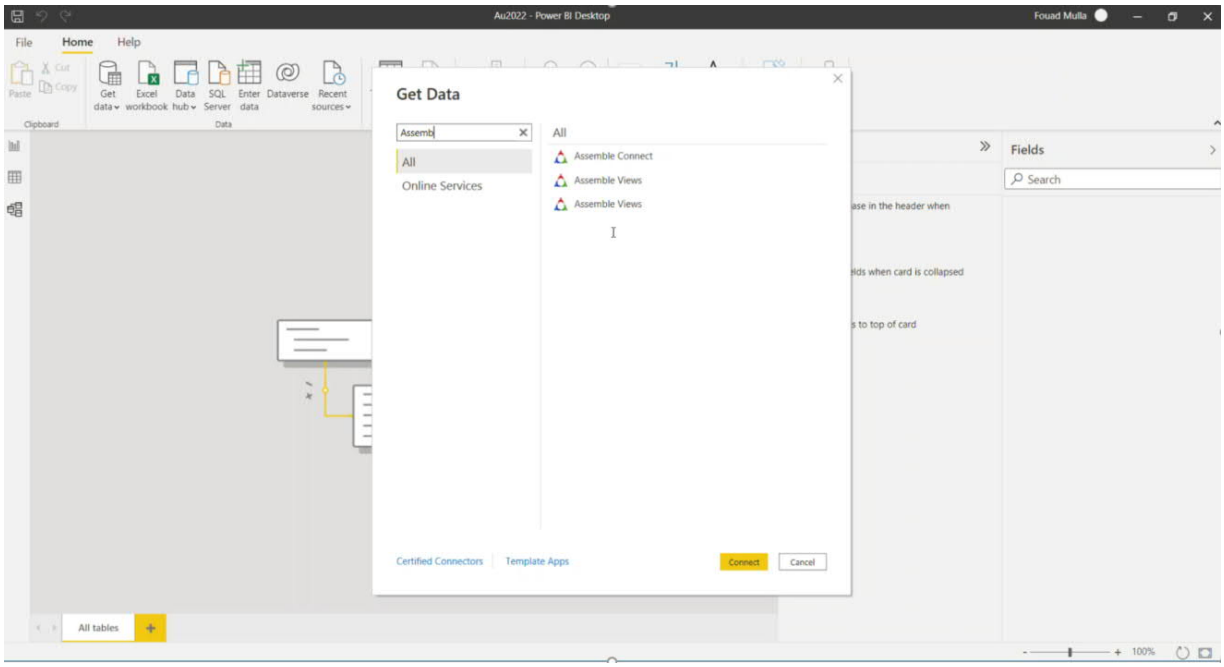
Linking the Power BI query to Assemble

1- Open a new Power Bi file.
2- Click on '*Get data*'.

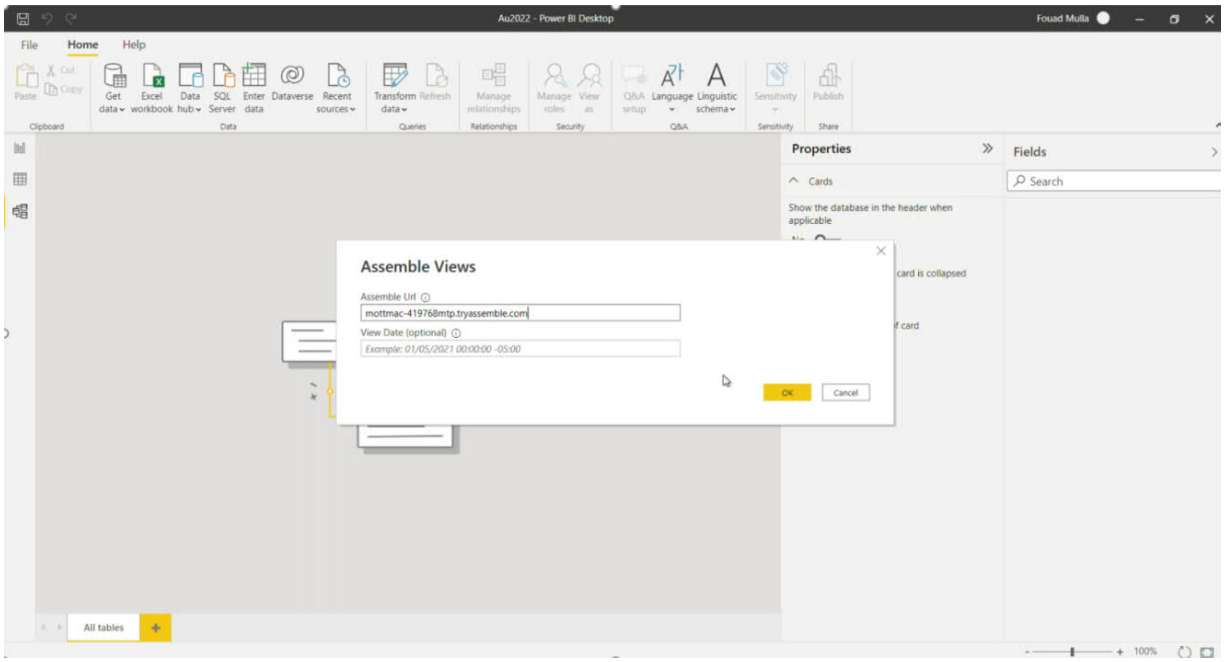


3- Search for Assemble connector and click "C*onnect*"

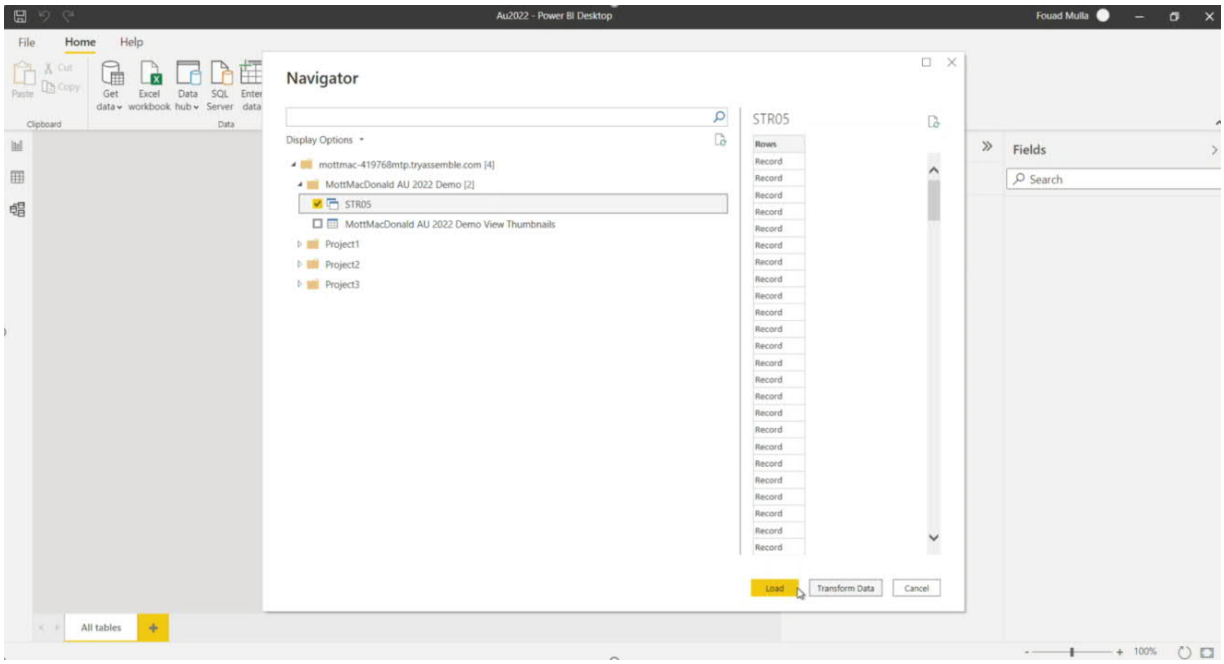
Note: Ensure you have the latest Power Bi so you can find the certified Assemble connector.



4- Copy and paste the main landing page URL of your Assemble account (Assemble URL).



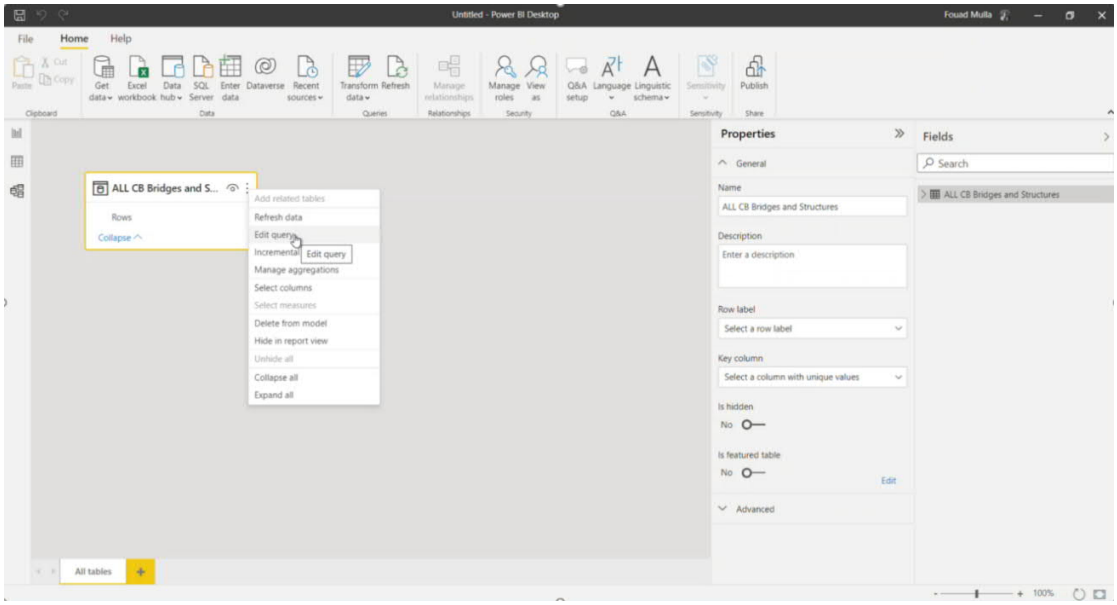
4- Expand the project and select the view you wish to import.

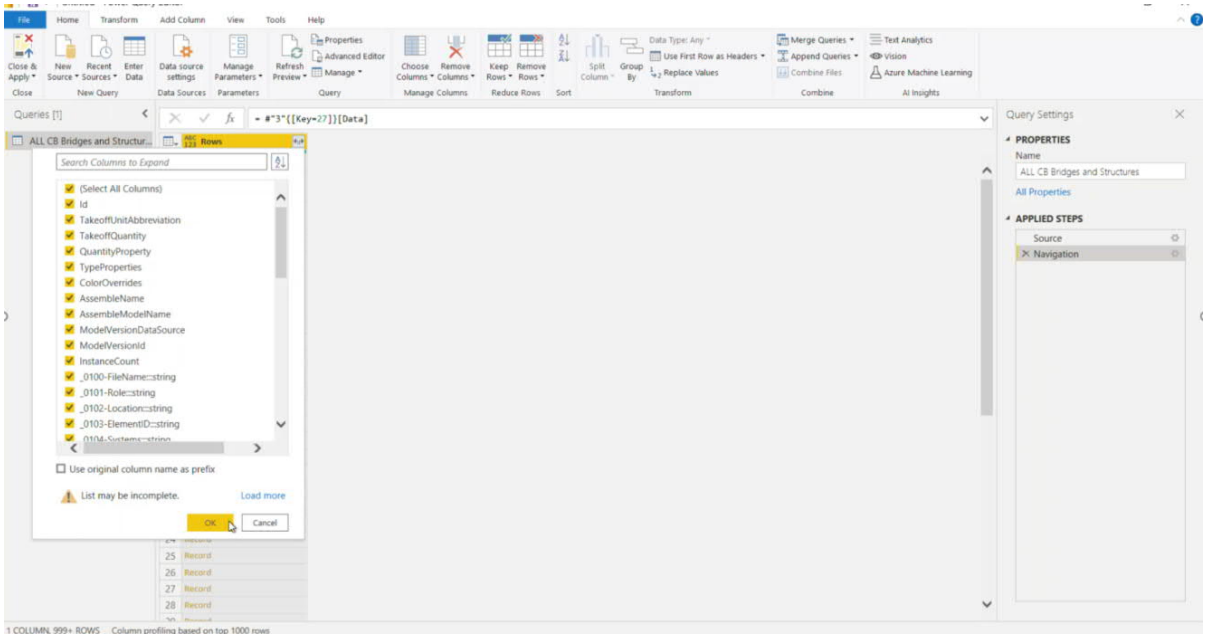


5- The database query will load and once it is ready, we can start cleaning the database.

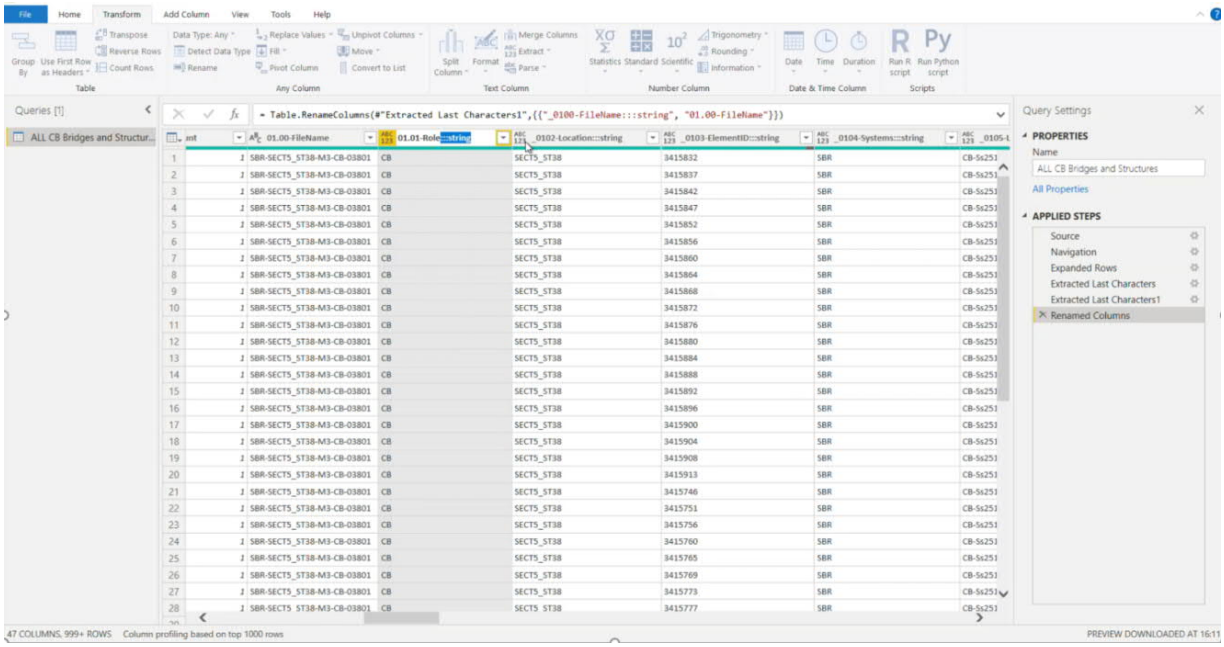
Data Cleansing

1- Click on the three dots of your database node then choose "*Edit Query*"
2- Expand the field by unchecking the check box (use original column name as prefix)
3- Review data for any errors in the column headings, format types or other similar issues.



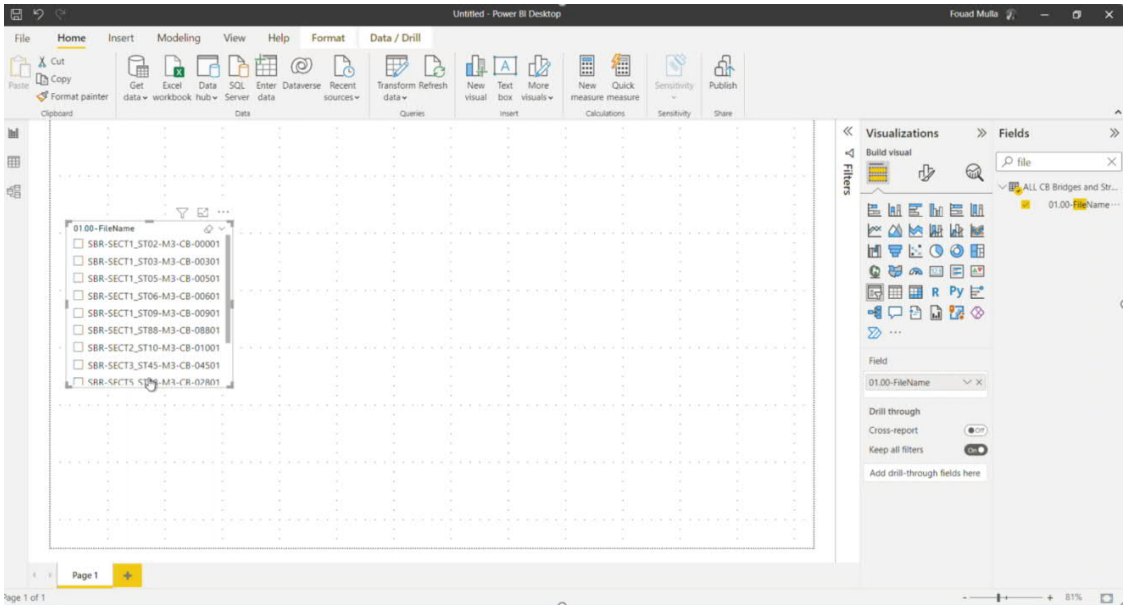


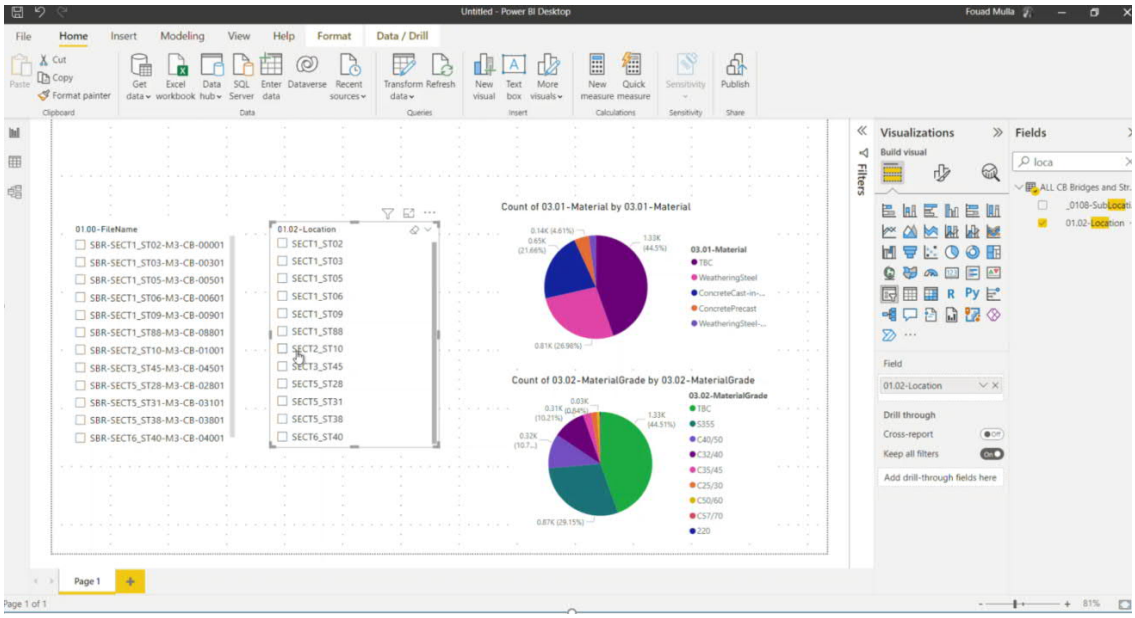
6- Use the data detection in Power BI “Transform” Ribbon to resolve any issue in the data type for example.



Defining the Power BI Dashboard

You can now add filter to your dashboard. In our example we added the *Filename* attribute column as a filter. You can add some visuals such as a pie chart and use the materials to visualize the data.



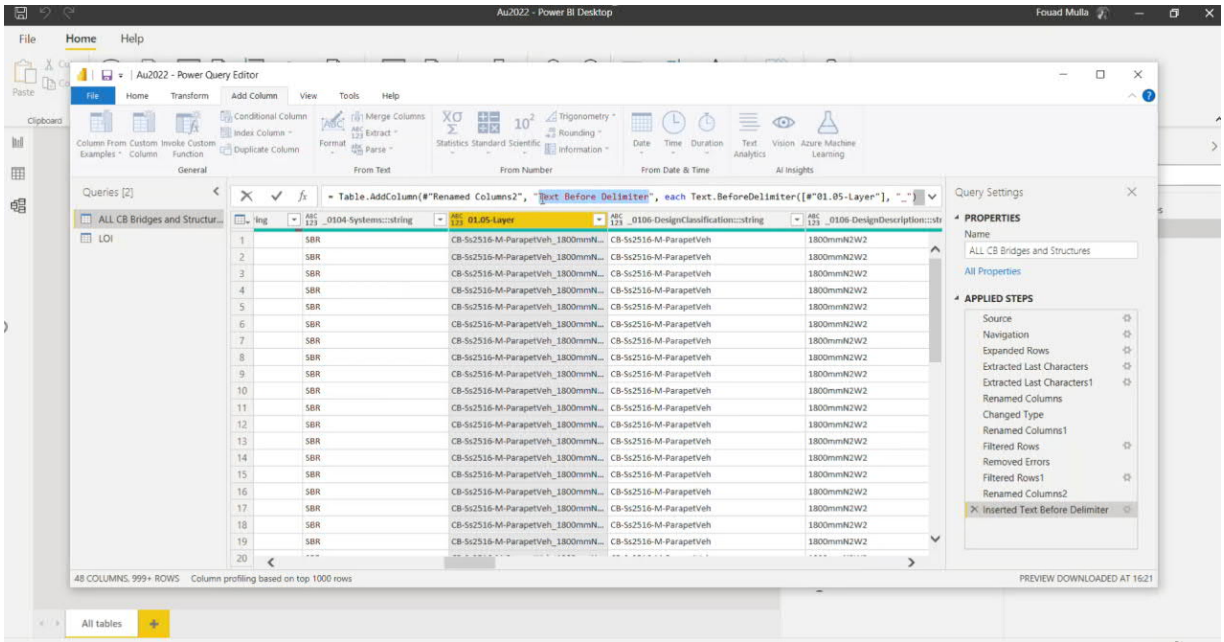


Creating a ‘Health Check’

Now we have the Assemble data connected to Power BI we can generate a conditional check to verify that the values defined in a specific attribute (e.g., Layer name) are compliant with the project standards. This ‘Health Check’ is a very powerful method for the project team to understand the compliance of the model attributes against the project standards. These checks should serve as the first or primary step validating project data as part of the model checking process.

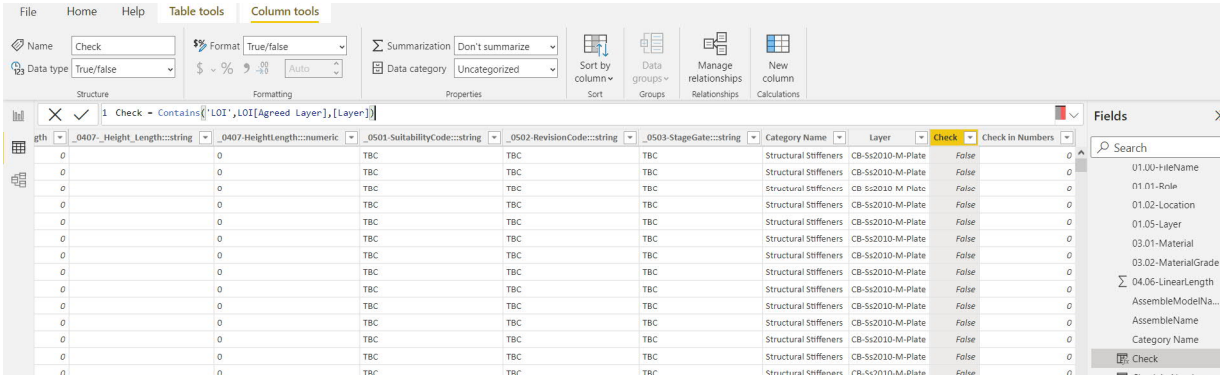
This section will show the steps to create a ‘Heath Check’.

1- Add the data source which you wish to validate against, which can be excel or any file hosting your data. Ensure the data is cleaned. In our case we needed to extract the string before delimiter in the “01.05 Layer” column then host the values in a new column and let’s call it “Layer”.



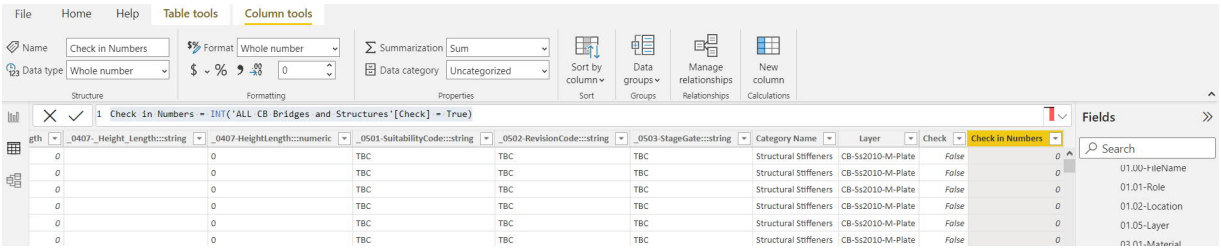
2- Select ‘*Data*’ tab to add the check columns.
3- Let’s add a check formula to confirm there is a string match between the “LOI Agreed Layer” column and the newly created *Layer* column. If the string matches, then the value will be “True” if not will be “False”
For that we can use the following formula:

```
Check = Contains('LOI',LOI[Agreed Layer],[Layer])
```

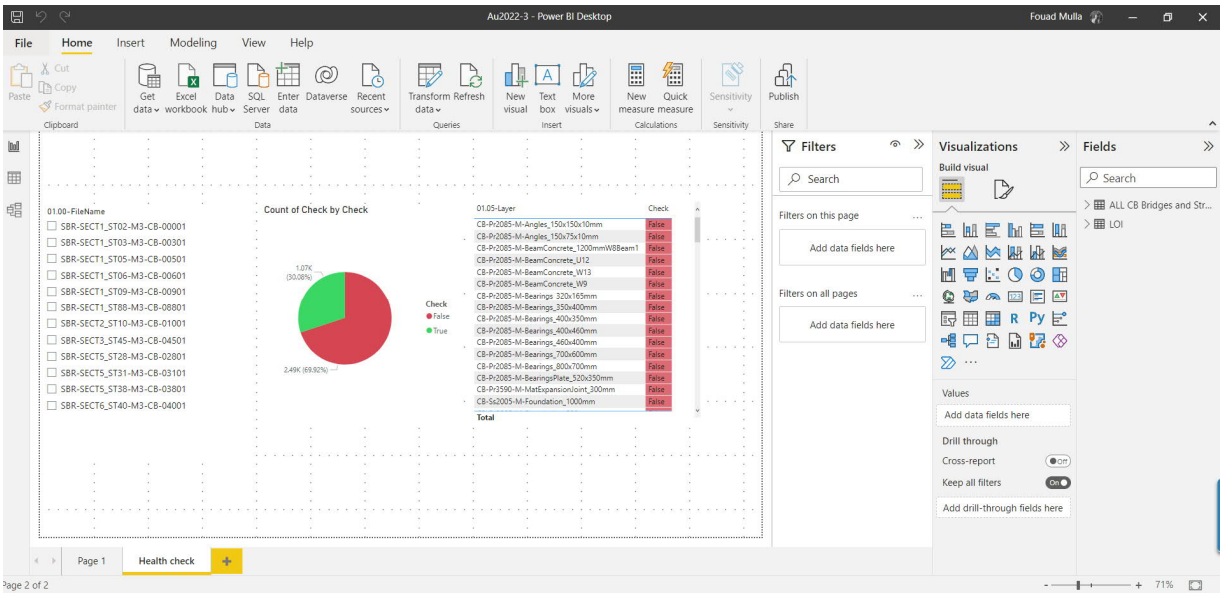


4- Then we need to translate the values to a number so we can use it to color code the results.
For that we can use the following formula:

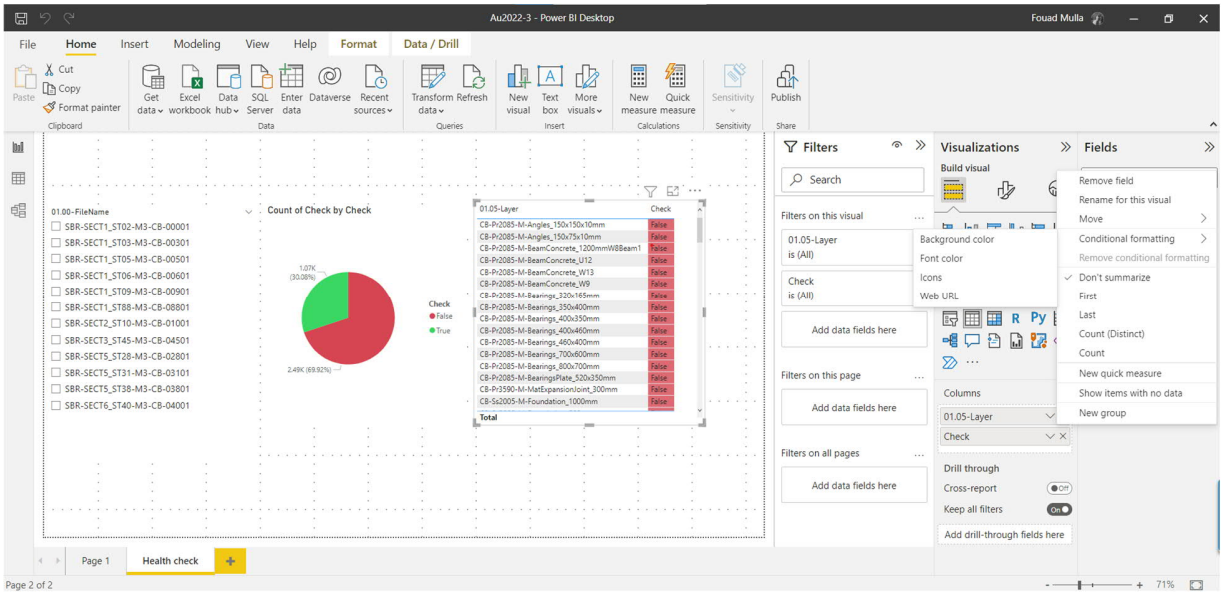
```
Check in Numbers = INT('ALL CB Bridges and Structures'[Check] = True)
```



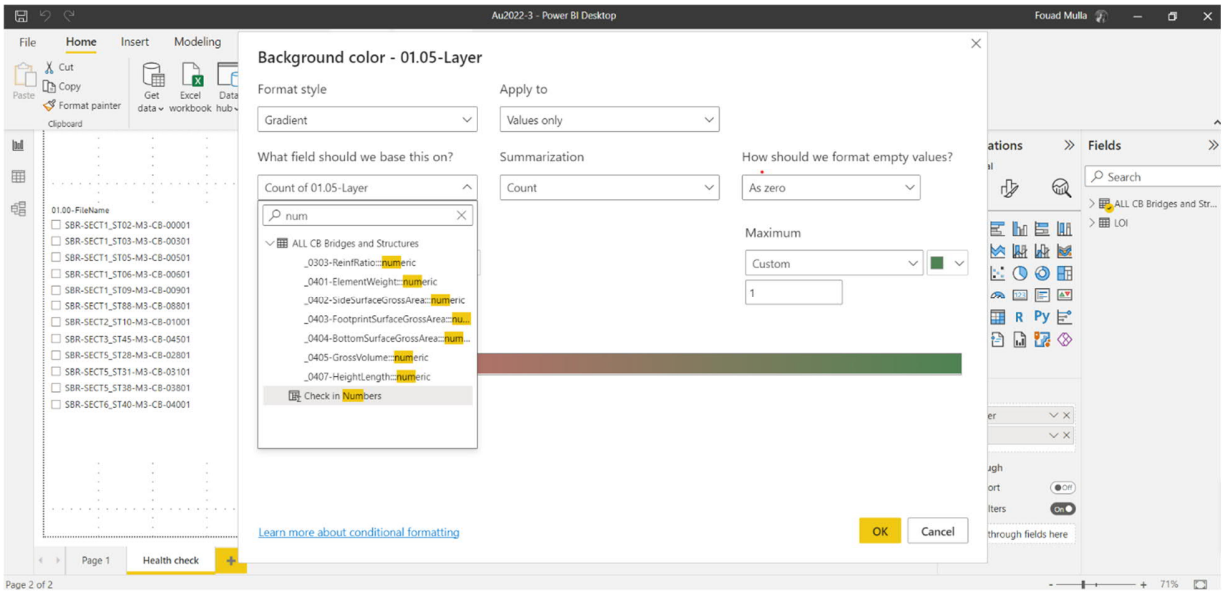
5- Click the '*Report*' tab and then create new page.
6- Add Filters as needed, Pie chart and Table or other visuals.



7- To add conditional formatting, right click on the check column and select "*Background color*"

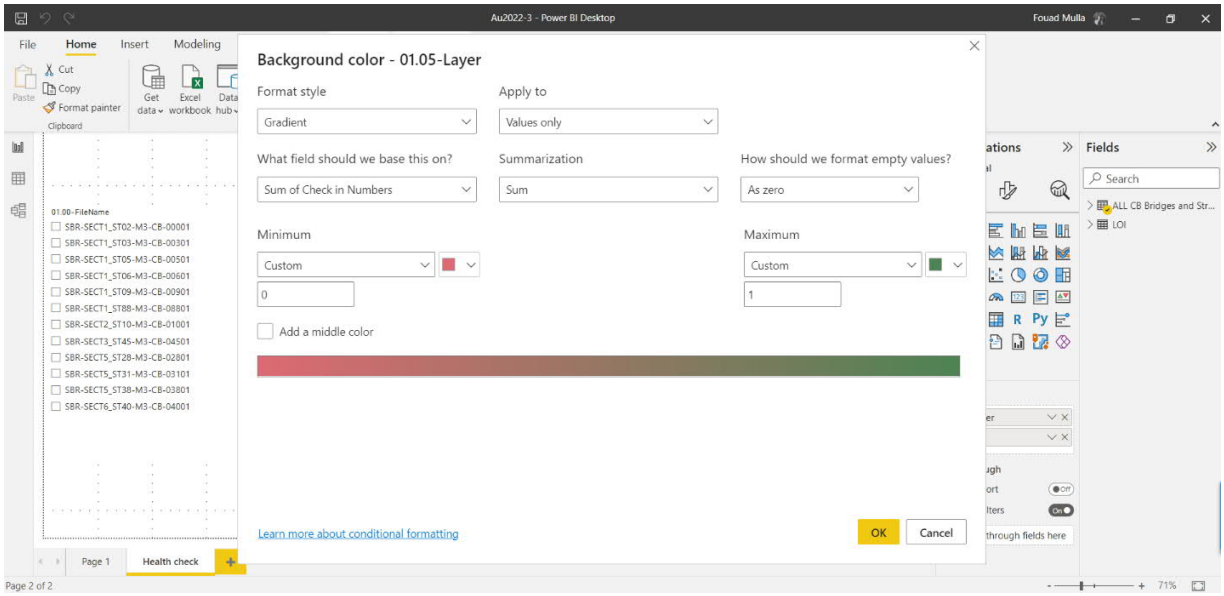


8- Change the option in "*What field should we base this on*?" to the "*Check in Numbers*" column.



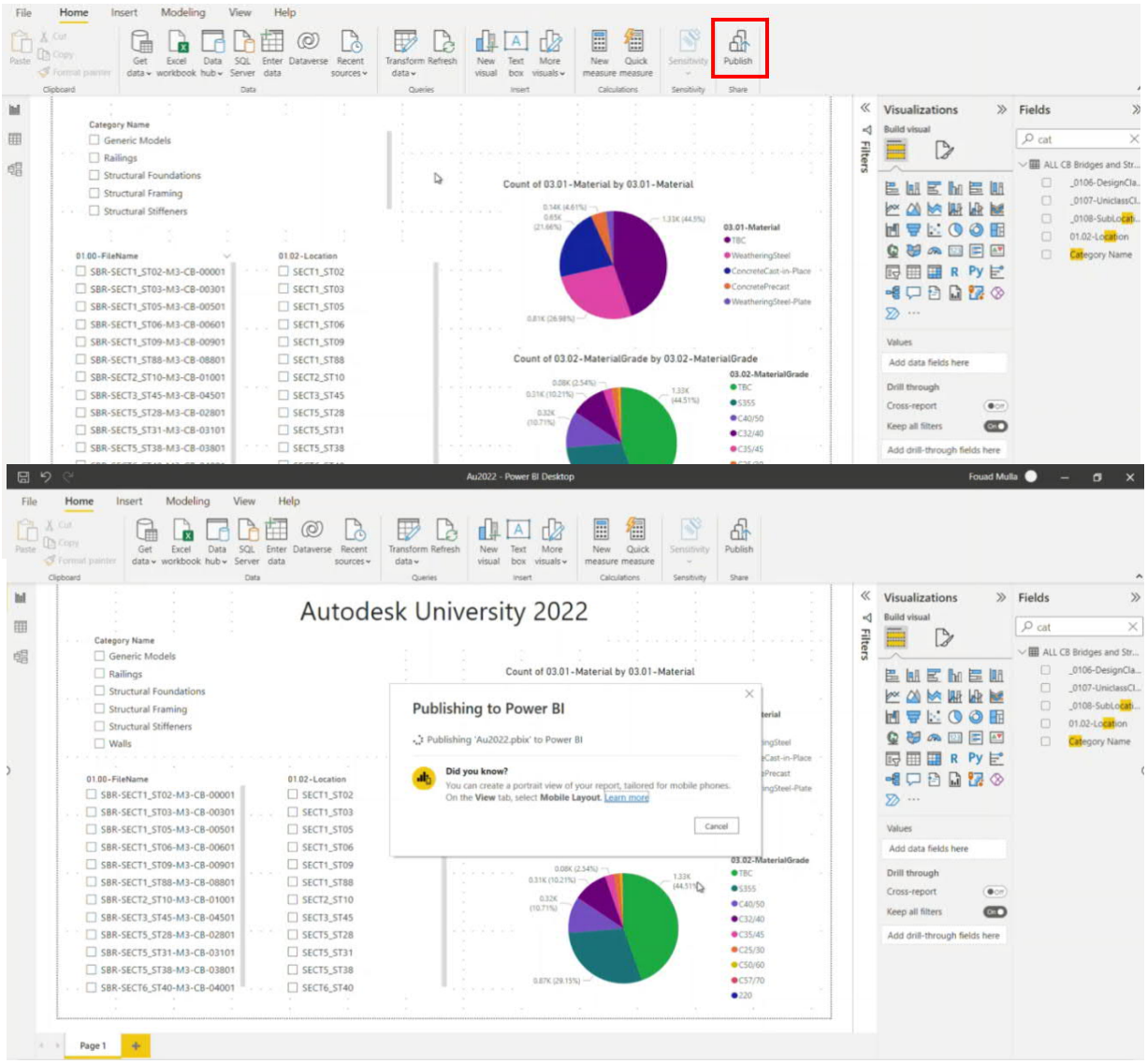
9- Choose the minimum range values as in the image, we should use 0 as minimum and 1 as a maximum value.

10- Select the required color code, click '*OK*'



Publish the dashboard

Once the dashboard is setup as required, it needs to be published for other users can access and interrogate the data. For that click on the “Publish” button as in the image then select the workspace where you wish to save this dashboard. Once done you can access your dashboard by clicking on the link as in the image below.



The Outcome

Since the development of the initial dashboard and once the project team became aware of the workflow and how model data is transferred, the dashboard became a central part of our model delivery cycle. As an easy-to-use method of understanding the model content, the project engineers became more comfortable engaging and communicating with the model production team when referencing the dashboard and being able to perform a ‘deep dive’ into each model element. This improved insight of the model content ensured the project team had a high-level of confidence the design intent was captured and moved us closer to the *Right First-time, On-Time* approach.

The dashboard itself required tweaks in the early stages to address both unexpected data translation issues, and to visualise or represent the data in a different format. On-going maintenance of the dashboard needs to be allowed for to ensure no degradation of the data and the project team retain a high level of confidence in the data represented.

We are now expanding the functionality to compare model quantities between different project milestones. Being able to communicate to our client the quantity variation as a result of design development or change means a previously challenging task is managed with confidence and clarity.

On a broader scale we are also developing guidance and playbook for Project Managers, Information Managers and Digital/BIM leads to implement this and similar model checking solutions across Mott MacDonald to enable not just the larger scale, digitally mature projects to leverage the advantages, but also for the small and medium scale projects.