Sungei Kadut Eco-District


Punggol Digital District

Loyang North 66kV Substation – A Data Transformation Journey

21 August 2023

Loyang North 66kV Substation

Overview

- Design team fully in-house except for Specialist Consultants
- Project is currently published in GEBIZ for tender
- 4-Storey CIS building with beam-slab system due to Security & Blast requirements
- Bored pile foundations

Project Highlights

- Piloting BIM for Tender
- 1st Project compliant to JTC's Model Content Requirement (MCR) from Prelim Design
- Pilot using Cubicost by Glodon for estimates of Builder's Works

Why Data?

BIM vs 3D Modelling

REVIT Tekla GRAPHISOFT Archicad

Digitalisation → **Data Transformation**

Geometric Data | **Parametric Data**

Hand drawn

Bentley MicroStation

AUTOCAD

2D Computer-aided Design

2D points, lines and objects

3D Modelling

3D geometric objects + 2D lines and objects. **Parametric information are "dead" text within drawings** e.g. rebar, concrete grade, etc

Frameworks
- **Tender/ Construction**
- **Agency's MCR**
- **IFC-SG (Corenet X)**

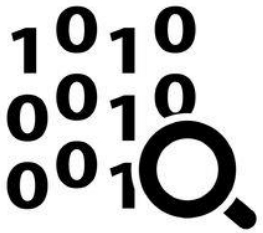
BIM = Geometric + Parametric Data

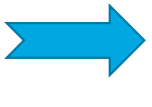
3D model + elements tagged with parametric information

*In many cases, "Digitalisation" and "Data Transformation" are used synonymously
** Software shown above are not exhaustive

Why Data? – Data and Automation Work Well Together

Useful Data





Algorithms

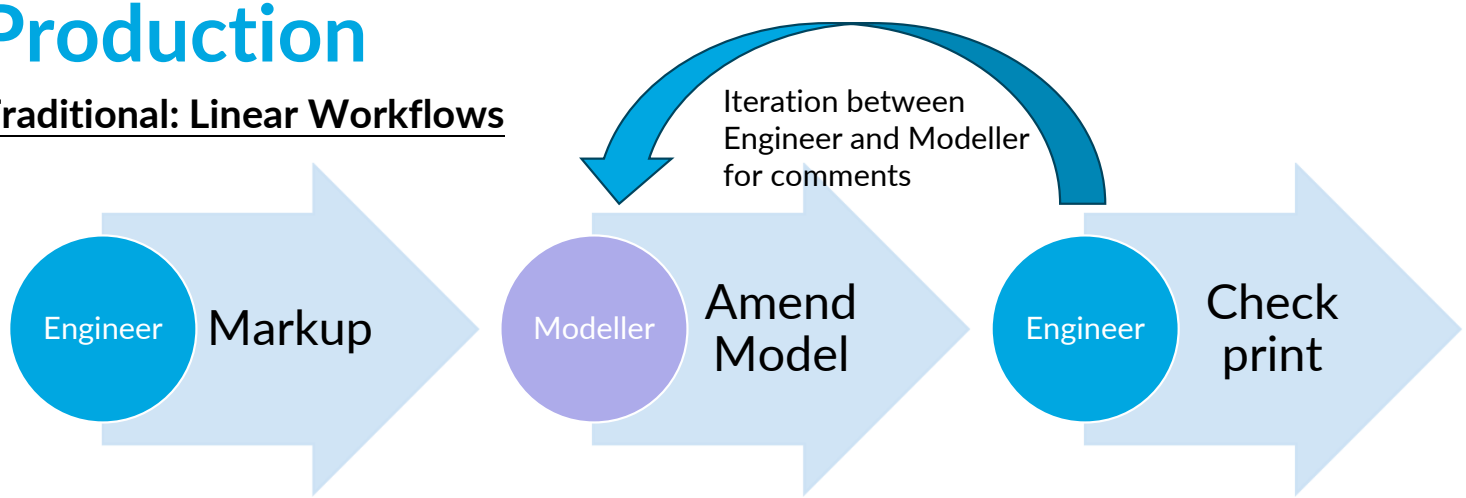
Increased Efficiency

Reduced Human Error

Revit Dynamo

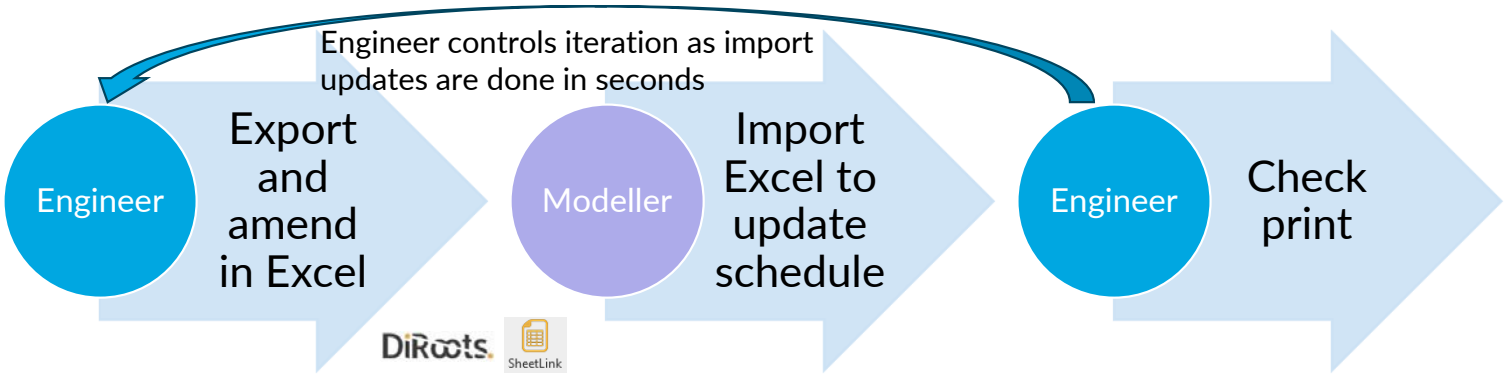
Why Data? – Empowering Engineers in Schedules Production

Traditional: Linear Workflows



Drawing for Issuance

Data: Concurrent Workflows



Drawing for Issuance

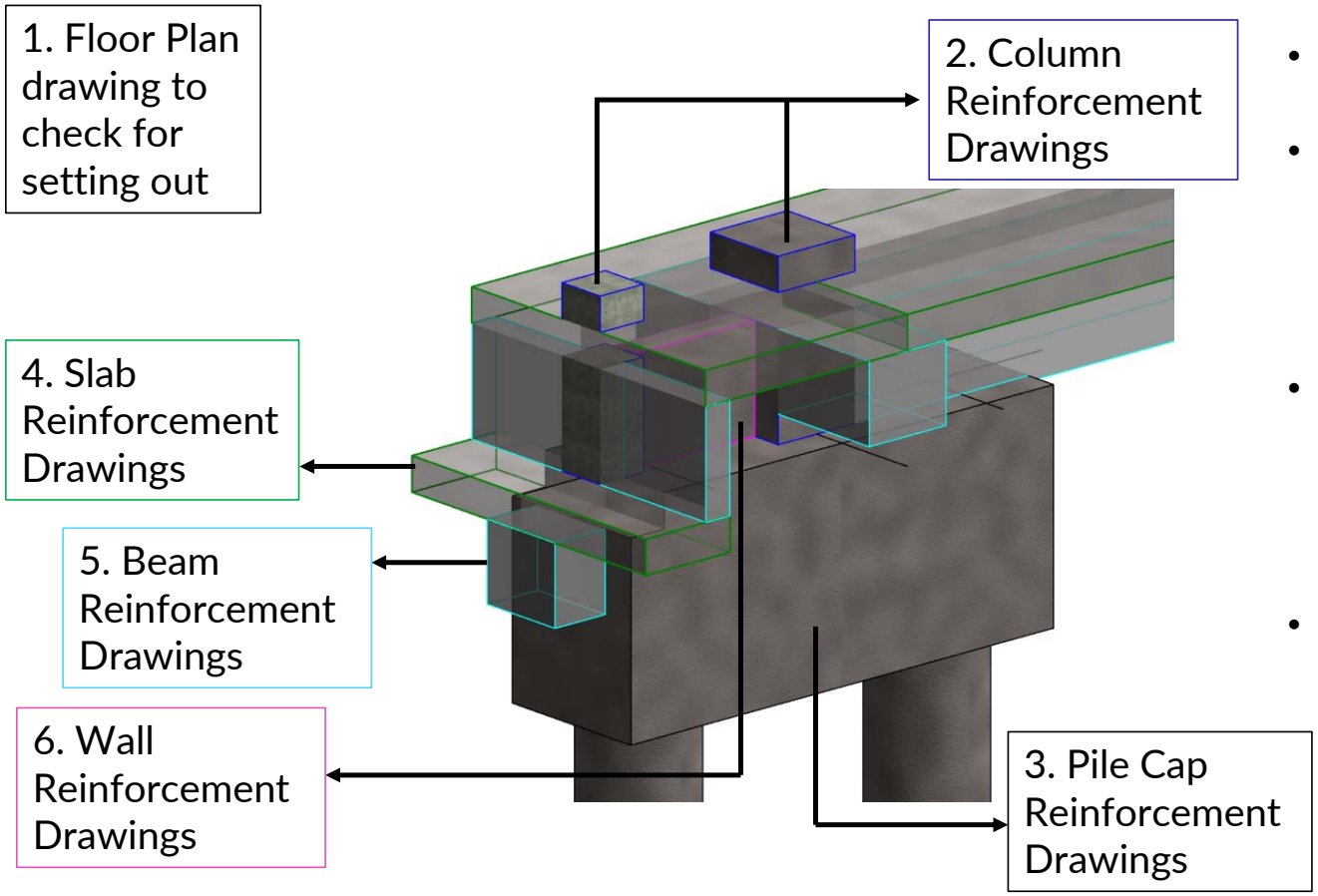
Why Data? – Benefits of Empowering Engineers in Schedules Production

https://theosophical.files.wordpress.com/2014/12/telephone-game.jpg

Reduce human error as Engineer directly inputs data into final source of truth

Reduce modelling time as “heavy lifting” is done outside of Revit

Why Data? – Data Simplifies Required Documents



- All latest information is in one 3D model
- An example of a complicated pile cap cast is shown on the left: **Minimum 6 sets of drawings are required for 1 cast**
- Traditionally, starter bars are easily missed out/ misplaced and rebar will have to be drilled in, resulting in additional cost/ time spent to rectify
- Possible for **site staff and Contractor to use IFC model for site checks** simplifying documents into **1 model** with all the required information

Why Data? - Better Visualisation of Design Reviews

ST_Beam Reinforcement Schedule For Unit 1&3 - Part 2

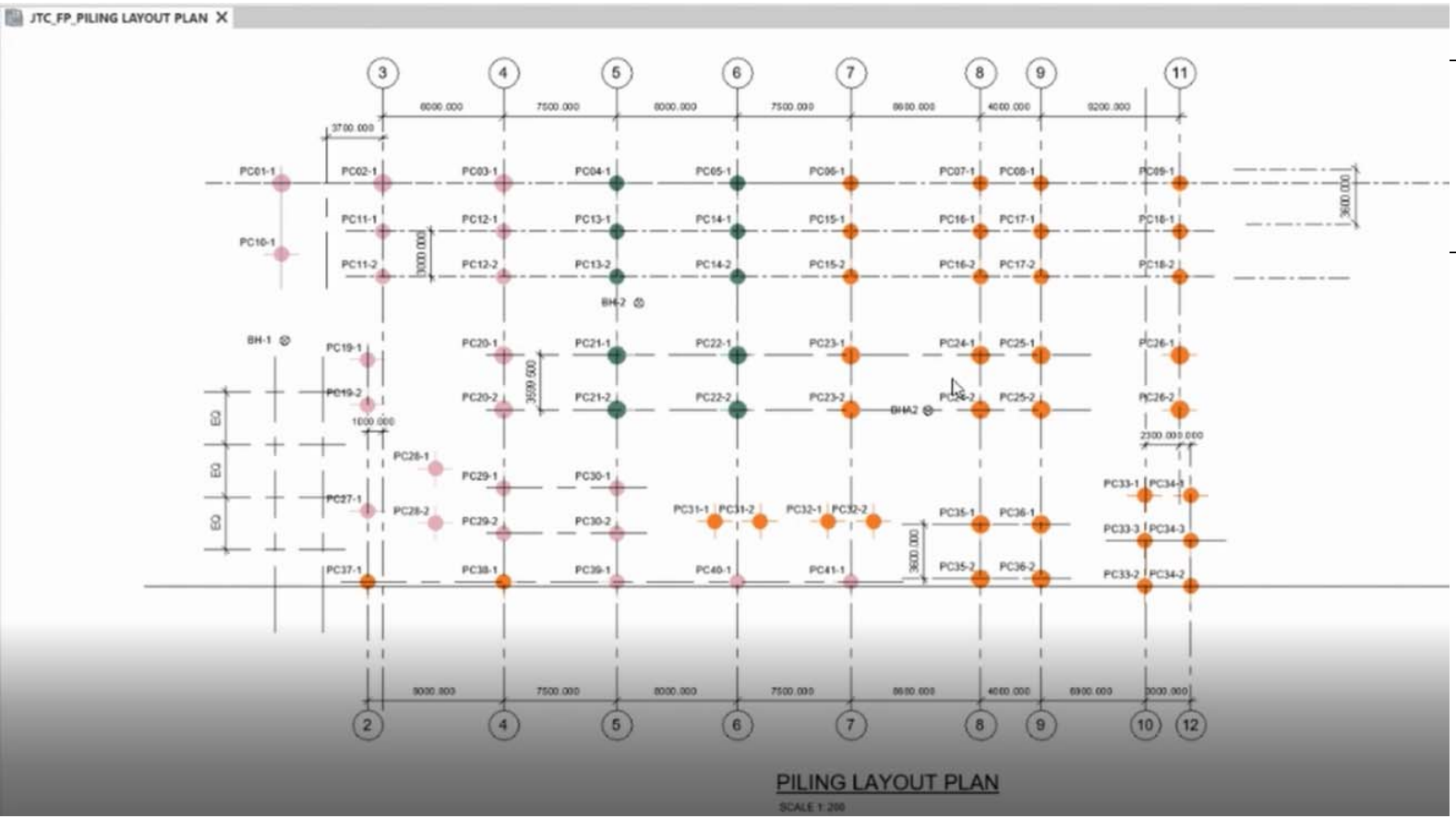
Beam	Beam Size		Single Span									Intermediate Span									End Span / Cantilever									
			Top Bars			Bottom Bars			Links			Top Bars			Bottom Bars			Links			Top Bars			Bottom Bars			Links			
Beam Mark	b	h	T1a	T2a	T3a	B1a	B2a	B3a	S1a	S2a	S3a	T1b	T2b	T3b	B1b	B2b	B3b	S1b	S2b	S3b	T1c	T2c	T3c	B1c	B2c	B3c	S1c	S2c	S3c	No. of Beam Mark
2V3-U13	400	800	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H25	3H25	-	H10-100	H10-200	H10-100	-	-	-	-	-	-	-	-	-	1
2V3A-U13	400	900	-	-	-	-	-	-	-	-	-	4H32 + 4H32	4H32	4H32 + 4H32	4H25	3H25	-	H10-100	H10-200	H10-100	-	-	-	-	-	-	-	-	-	1
2V4-U13	400	800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H16	-	-	H10-100	H10-100	H10-100	1
2V5-U13	400	800	4H20	-	-	4H32	4H20	-	H10-200	H10-200	H10-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2V6-U13	200	900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2H16	2H16	2H16	2H16	-	-	H10-250	H10-250	H10-250	1
2V6A-U13	200	800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2H16	2H16	2H16	2H16	-	-	H10-250	H10-250	H10-250	1
2V7-U13	200	900	2H25	-	-	2H25	2H25	2H25	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2V8-U13	400	800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H25	4H25	4H25 + 4H25	4H25	4H20	-	H10-150	H10-150	H10-150	1
2V9-U13	400	900	-	-	-	-	-	-	-	-	-	4H25 + 4H25	4H25	4H25 + 4H25	4H25	-	-	H10-100	H10-100	H10-100	-	-	-	-	-	-	-	-	-	1
2V10-U13	400	800	-	-	-	-	-	-	-	-	-	4H25 + 4H25	4H25	4H25 + 4H25	4H25	4H16	-	H10-100	H10-200	H10-100	-	-	-	-	-	-	-	-	-	1
2V11-U13	400	900	-	-	-	-	-	-	-	-	-	4H25 + 4H25	4H25	4H32 + 4H32	4H25	4H16	-	H10-100	H10-200	H10-100	-	-	-	-	-	-	-	-	-	1
2V12-U13	400	900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H25	4H25	-	H10-100	H10-200	H10-100	1
2V13-U13	400	800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H25	4H25	4H25 + 4H16	4H25	-	-	H10-200	H10-200	H10-200	1
2V14-U13	400	900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H25	4H25	4H25 + 4H16	4H25	-	-	H10-200	H10-200	H10-200	1
2V15-U13	250	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3H25	3H25	3H25 + 3H30	3H25	2H16	-	H10-250	H10-250	H10-250	1
2V16-U13	250	500	-	-	-	-	-	-	-	-	-	2H25 + 2H20	2H25	2H25 + 2H20	2H25	2H16	-	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	1
2V17-U13	250	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3H25	3H25	3H25 + 2H20	3H25	2H16	-	H10-250	H10-250	H10-250	1
2V18-U13	250	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2H25	2H25	2H25 + 2H20	2H25	-	-	H10-250	H10-250	H10-250	1
2V19-U13	250	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2H25	2H25	2H25 + 2H20	2H25	-	-	H10-250	H10-250	H10-250	1
RH1-U13	400	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H16	4H16	4H20	4H20	-	-	H10-250	H10-250	H10-250	1
RH2-U13	400	500	-	-	-	-	-	-	-	-	-	4H20	4H25	4H25 + 4H20	4H16	-	-	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	1
RH3-U13	400	500	-	-	-	-	-	-	-	-	-	4H25 + 4H20	4H25	4H32 + 4H20	4H20	4H20	-	H10-150	H10-250	H10-150	-	-	-	-	-	-	-	-	-	1
RH4-U13	400	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H16	4H16	4H20	4H20	-	-	H10-250	H10-250	H10-250	1
RH5-U13	400	500	-	-	-	-	-	-	-	-	-	4H20	4H32	4H32 + 4H16	4H16	-	-	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	1
RH6-U13	400	600	-	-	-	-	-	-	-	-	-	4H32 + 4H16	4H32	6H32 + 4H32	4H32	4H16	-	H10-75	H10-150	H10-75	-	-	-	-	-	-	-	-	-	1
RH7-U13	400	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H19	4H16	4H20	4H20	-	-	H10-250	H10-250	H10-250	1
RH8-U13	600	600	-	-	-	-	-	-	-	-	-	4H20	4H25	4H25 + 4H20	4H16	-	-	2H10-250	2H10-250	2H10-250	-	-	-	-	-	-	-	-	-	2
RH9-U13	600	600	-	-	-	-	-	-	-	-	-	4H20 + 4H20	4H25	4H32 + 4H20	4H20	4H20	-	2H10-250	2H10-250	2H10-250	-	-	-	-	-	-	-	-	-	2
RH10-U13	400	600	4H16	-	-	4H25	-	-	H10-200	H10-250	H10-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RH10A-U13	200	600	2H16	-	-	2H16	-	-	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RH11-U13	200	600	2H16	-	-	2H25	-	-	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RH11A-U13	400	600	4H16	-	-	4H25	-	-	H10-200	H10-250	H10-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RH12-U13	400	600	4H16	-	-	4H25	-	-	H10-200	H10-250	H10-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RH12A-U13	400	600	4H16	-	-	4H25	-	-	H10-200	H10-250	H10-200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RH13-U13 *	250	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2H25	2H25	2H25	2H25	-	-	H10-200	H10-200	H10-200	1*
RH14-U13 *	250	600	-	-	-	-	-	-	-	-	-	3H25	3H25	3H25	3H25	-	-	H10-200	H10-200	H10-200	-	-	-	-	-	-	-	-	-	1*
RV1-U13	400	650	4H32	-	-	4H32	4H32	-	H10-150	H10-250	H10-150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RV1A-U13	400	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H16	4H16	4H16	4H16	-	-	H10-250	H10-250	H10-250	1
RV2-U13	400	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	-	-	4H16	-	-	H10-250	H10-250	-	1
RV2A-U13	400	600	-	-	-	-	-	-	-	-	-	4H16	4H32	4H32 + 4H25	4H25	4H20	-	H10-150	H10-250	H10-150	-	-	-	-	-	-	-	-	-	1
RV3-U13	400	600	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H32	4H25	-	H10-100	H10-200	H10-100	-	-	-	-	-	-	-	-	-	1
RV3A-U13	400	600	-	-	-	-	-	-	-	-	-	4H32 + 4H25	4H32	4H32 + 4H32	4H32	4H25	-	H10-100	H10-200	H10-100	-	-	-	-	-	-	-	-	-	1
RV4-U13	400	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H20	-	-	H10-100	H10-100	H10-100	1
RV5-U13	400	650	4H32	-	-	4H32	4H32	-	H10-100	H10-200	H10-100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RV6-U13	200	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3H16	3H16	3H16	3H16	-	-	H10-250	H10-250	H10-250	1
RV7-U13	200	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2H16	2H16	2H16	2H16	-	-	H10-250	H10-250	H10-250	1
RV8-U13	200	600	2H16	2H16	2H16	2H16	-	-	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
RV9-U13	600	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H20	4H25	4H20	-	2H10-250	2H10-250	2H10-250	2
RV10-U13	600	600	-	-	-	-	-	-	-	-	-	4H32 + 4H20	4H20	4H32 + 4H20	4H25	4H20	-	2H10-250	2H10-250	2H10-250	-	-	-	-	-	-	-	-	-	2
RV11-U13	600	600	-	-	-	-	-	-	-	-	-	4H32 + 4H20	4H20	4H32 + 4H20	4H25	4H20	-	2H10-250	2H10-250	2H10-250	-	-	-	-	-	-	-	-	-	2
RV12-U13	400	600	-	-	-	-	-	-	-	-	-	4H32 + 4H20	4H20	4H32 + 4H32	4H25	4H20	-	H10-150	H10-250	H10-150	-	-	-	-	-	-	-	-	-	1
RV13-U13	400	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H32	4H26	-	H10-100	H10-200	H10-100	1
RV14-U13	400	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H25	4H25	-	H10-100	H10-200	H10-100	1
RV15-U13	400	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H26	4H25	-	H10-100	H10-200	H10-100	1
RV16-U13	250	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2H16	2H16	2H25	2H25	-	-	H10-250	H10-250	H10-250	1
RV17-U13	250	600	-	-	-	-	-	-	-	-	-	2H25	2H16	2H25	2H25	2H25	-	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	1
RV18-U13	250	600	-	-	-	-	-	-	-	-	-	3H26	3H16	3H26	3H26	3H26	-	H10-250	H10-250	H10-250	-	-	-	-	-	-	-	-	-	1
RV19-U13	400	650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H25	4H25	-	H10-100	H10-200	H10-100	1
RV20-U13	400	650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4H32	4H32	4H32 + 4H32	4H26	4H26	-	H10-100	H10-200	H10-100	1

Typical Beam Reinforcement Schedule

Typical reviews (by senior engineer/ QP) for reinforcement are by looking through tables such as the one on the left alongside the floor plans.

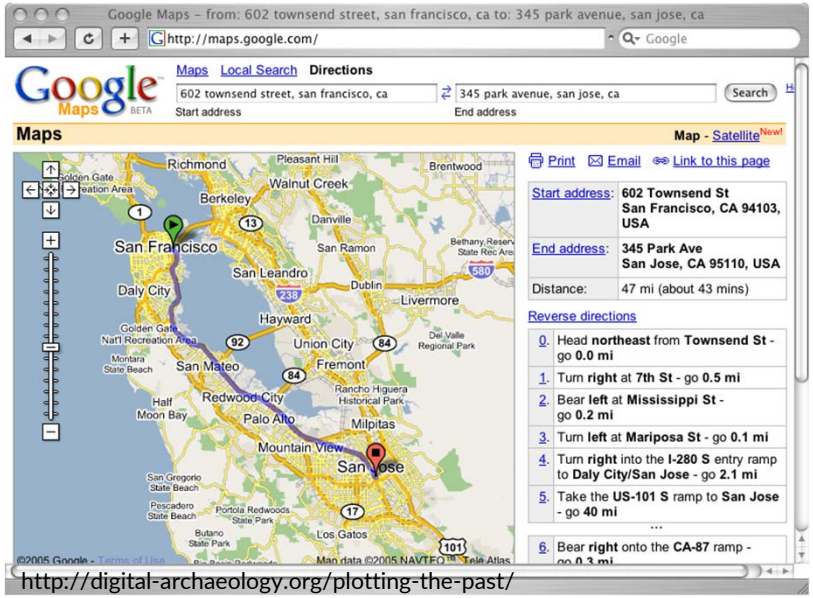
Finding errors is a test of eyesight and experience with plenty of room for error.

Why Data? - Visualise Design Reviews using BIM

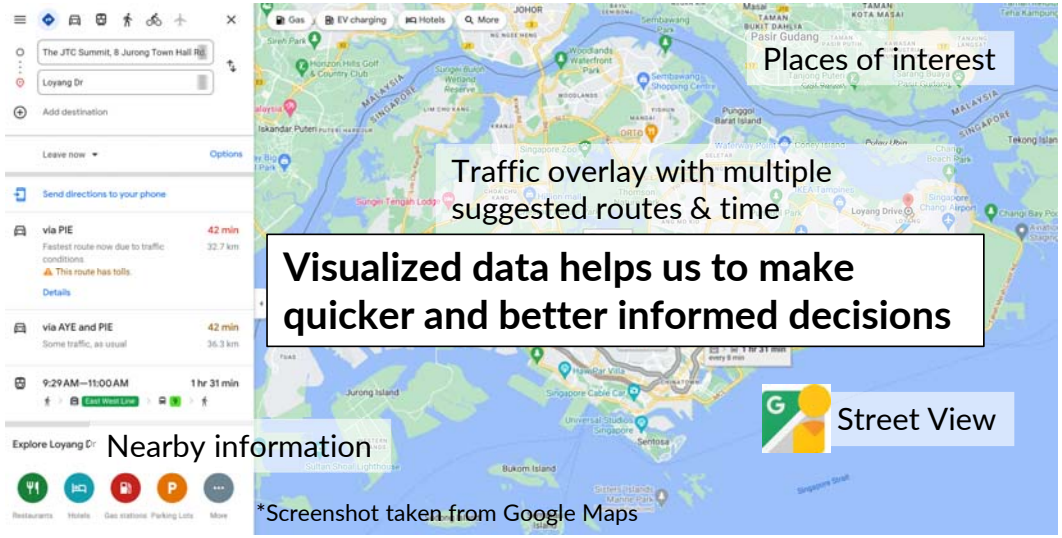


If parameters are set up correctly, modeller/ engineer can zoom in on issues visually

Why Data? - It will Breed Innovation and Value-Add



http://digital-archaeology.org/plotting-the-past/



Google Maps 2005

Google Maps now

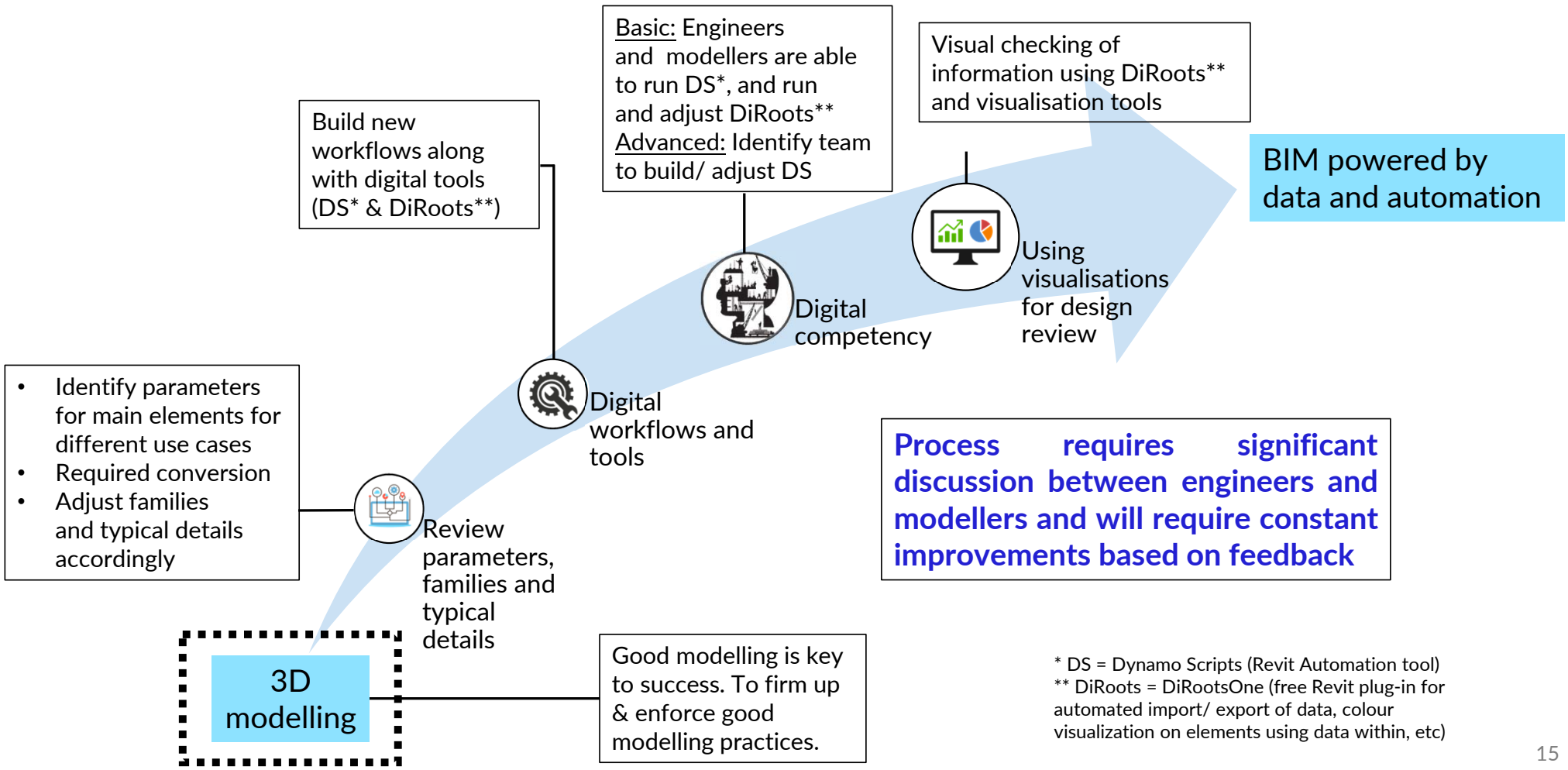
How to Implement?

Overcome Fear

"The fear of the unknown is so powerful, it convinces us to stay in the misery of our current situation simply because we know it already"

- Tony Eletto

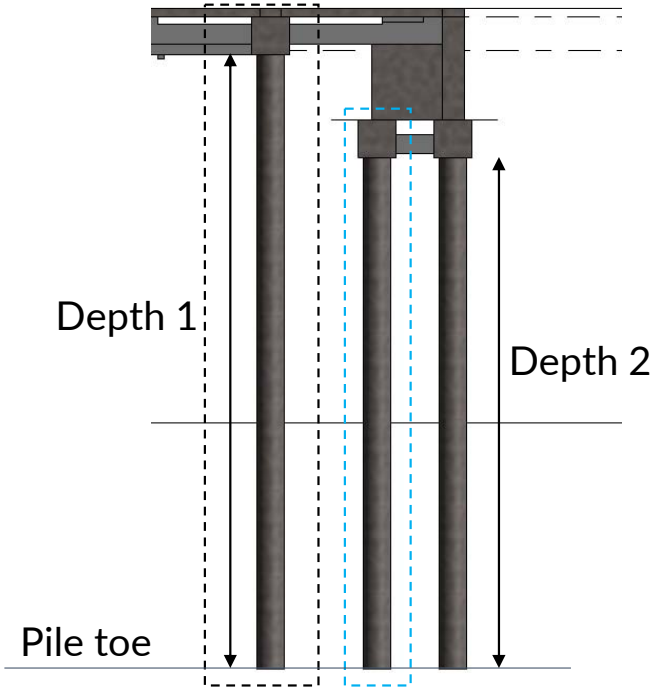
Steps to Implementing Data Approach



* DS = Dynamo Scripts (Revit Automation tool)
** DiRoots = DiRootsOne (free Revit plug-in for automated import/ export of data, colour visualization on elements using data within, etc)

3D Modelling – Some Considerations

Example of Foundations



Comparison of 2 piles with same pile toe but different COL

Suitable Families

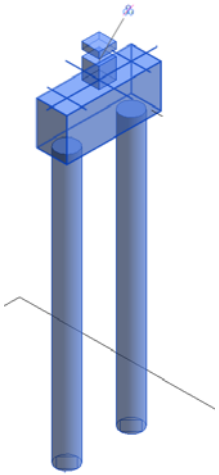
Initially, our pile families had fixed lengths which meant creating multiple Types for same pile with same diameter. BCA colleagues shared pile family with variable pile lengths which enabled us in streamlining workflows.

Group or Individual

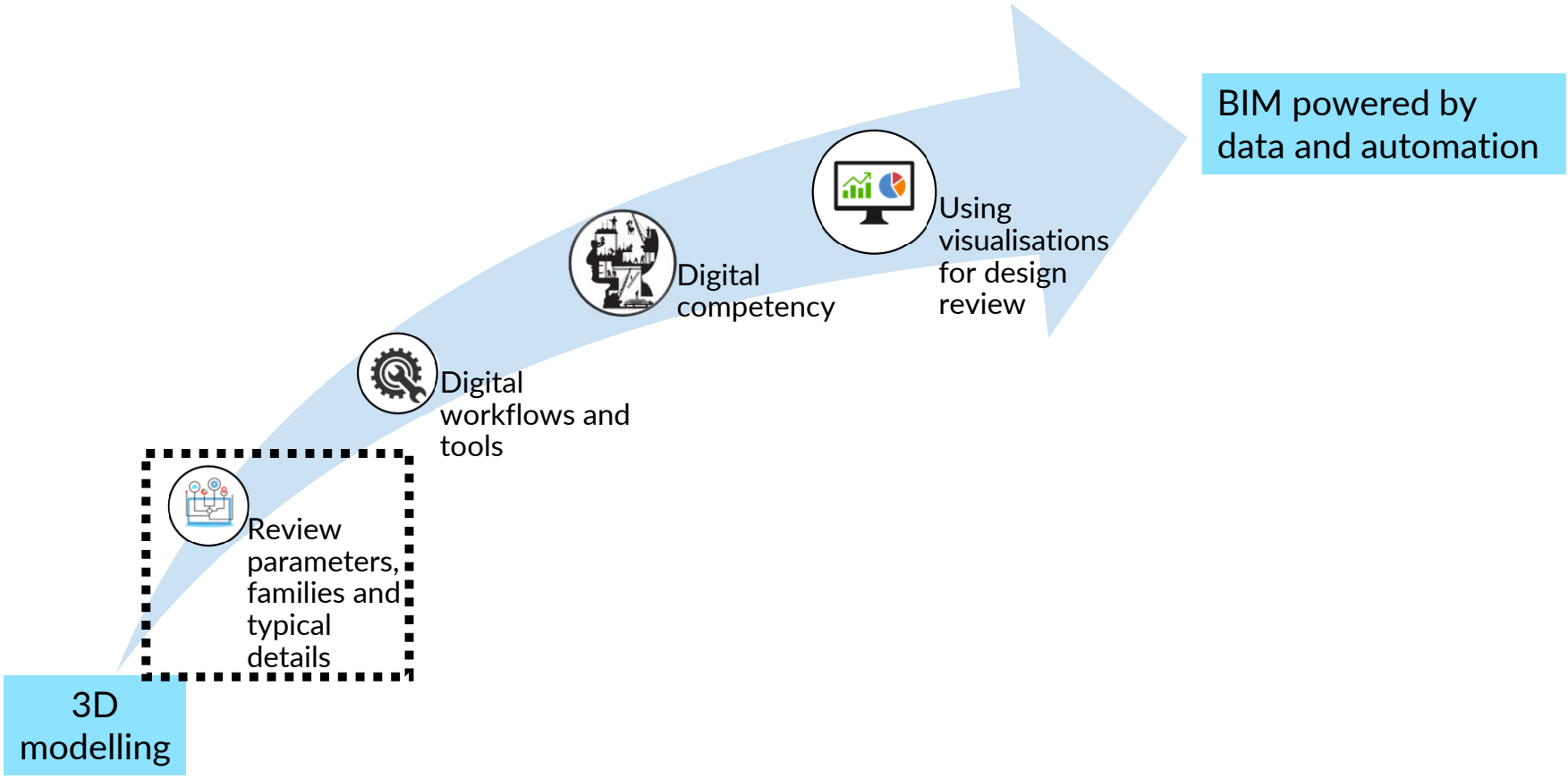
Another decision is whether to combine Pile Caps with Piles in 1 family. We decided to split the piles and pile caps to ease automation of pile length changes.

Later on, Glodon also shared with us that splitting is good practice for using Cubicost to build a cost model.

Modelling practices of each element type has to be reviewed by both modellers and engineers.



Steps to Implement Data Approach



Data Frameworks

Native Format
e.g. Revit

Design/ Tender/ Construction

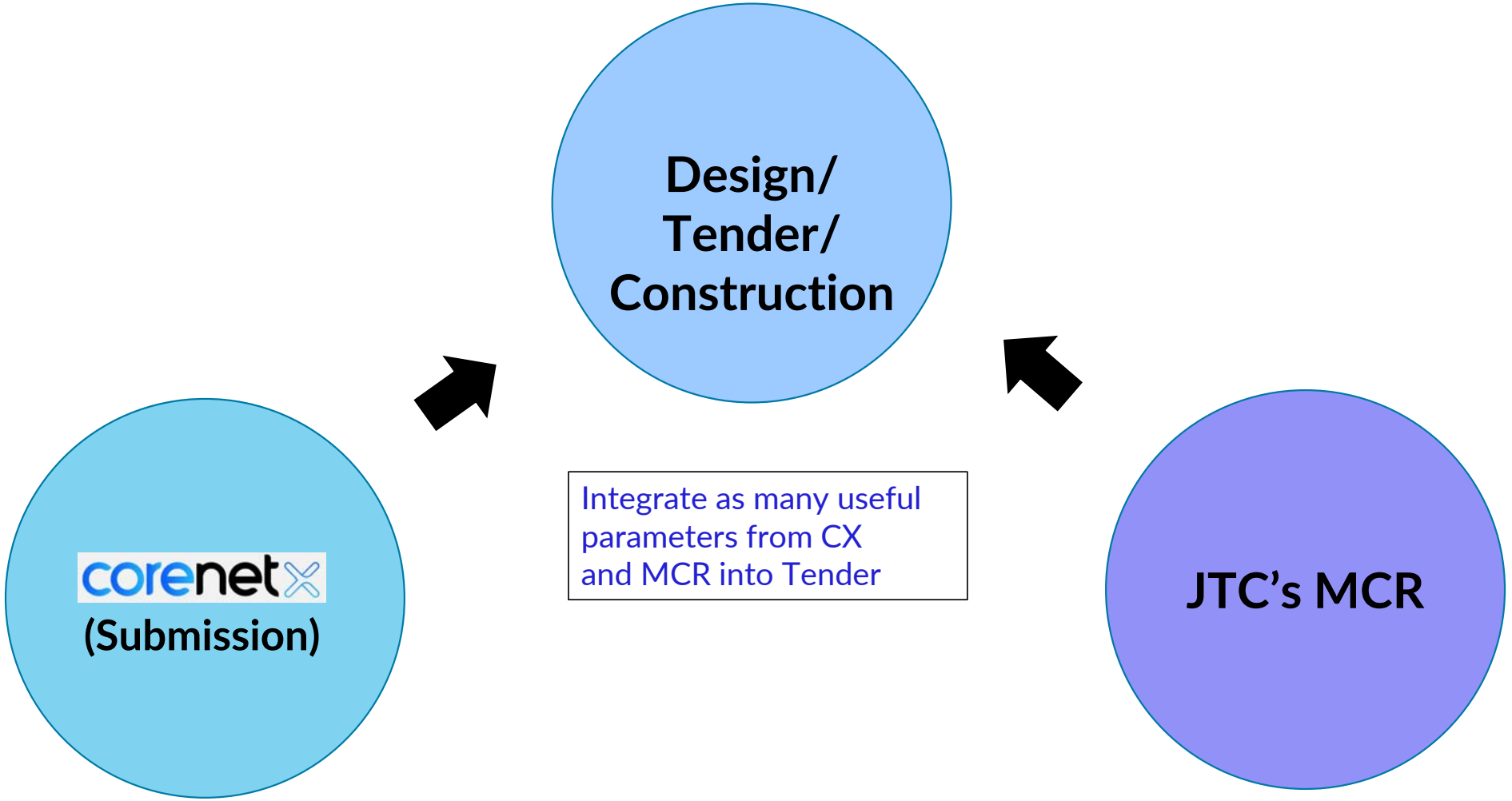
JTC's MCR
(Marketing, Asset management, Quantity take-off for Embodied Carbon/Costing, Design Review)

OpenBIM Format
i.e. IFC

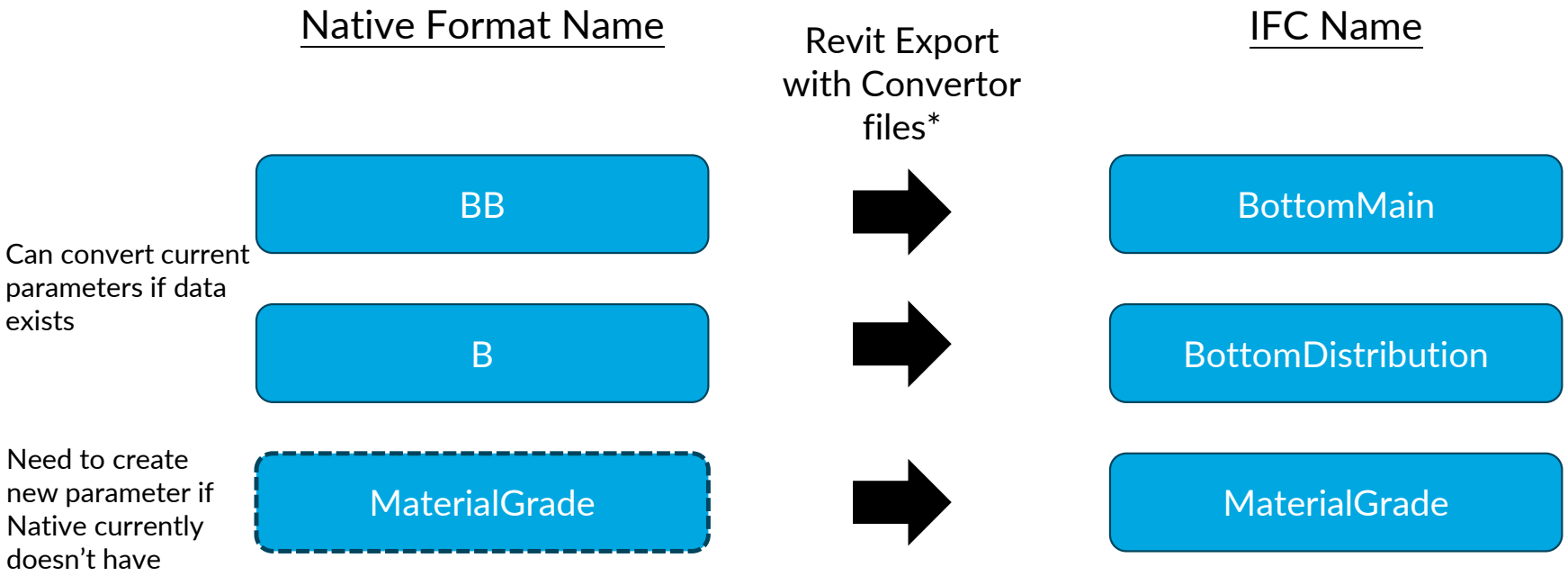
corenetX
(Submission)

Due to the **difference in usage**, parameters are not common across frameworks. Need to **harmonise** and if unable, to convert.

Data Frameworks



Parameters in Native BIM vs IFC



*BCA Corenet X team will be able to provide more details on this

Reviewing Parameters – Types of Parameters

Shared Parameters

- Maintained in text file
- Can be loaded in family and projects
- If loaded into single family can be used to control geometry
- If loaded into project, can be used to create schedules

Global Parameters

To control multiple components
within the same parameter
within a Revit Project

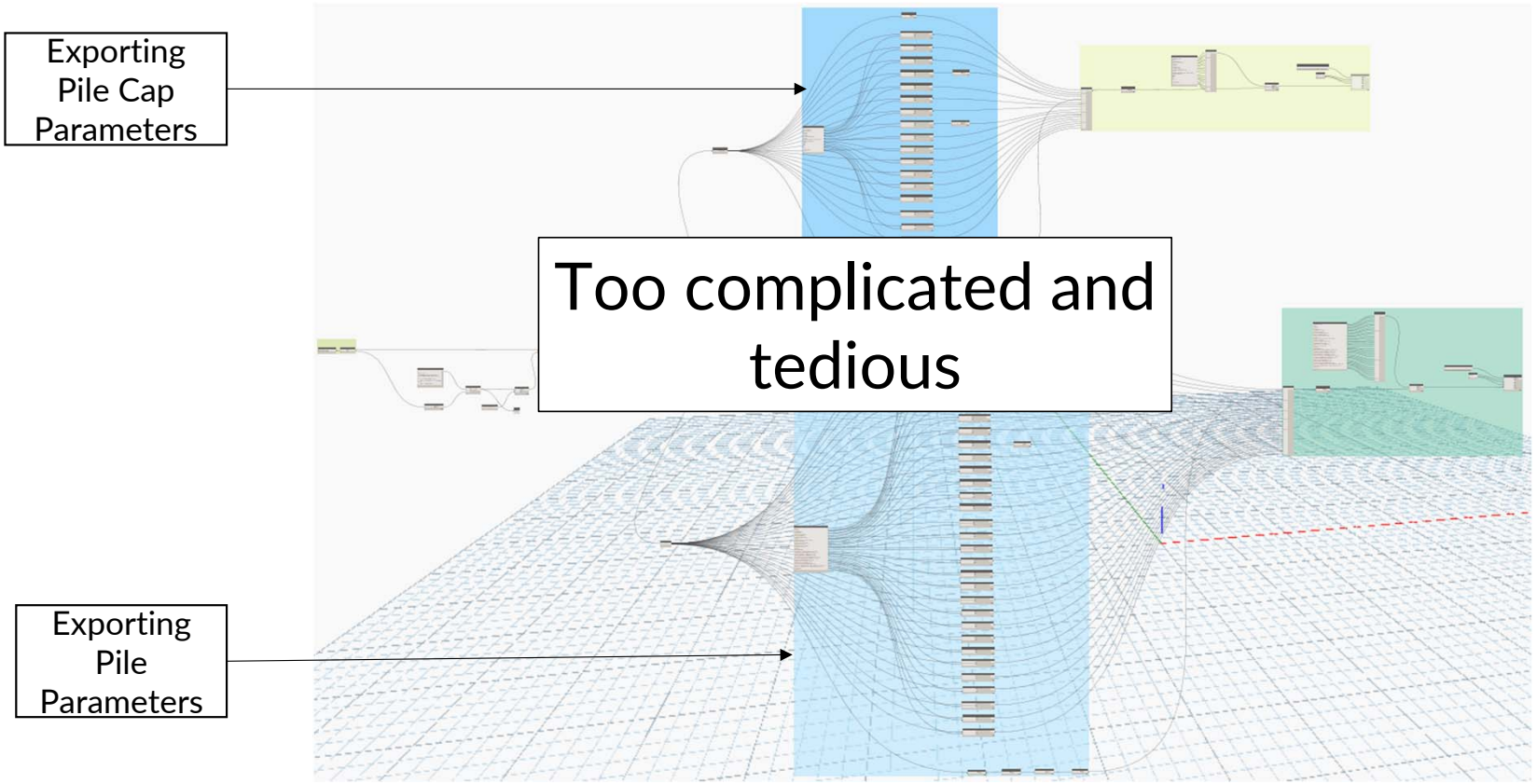
Family Parameters

Only exists within Revit family. All Revit family templates (RFT) contain standard parameters that cannot be removed.

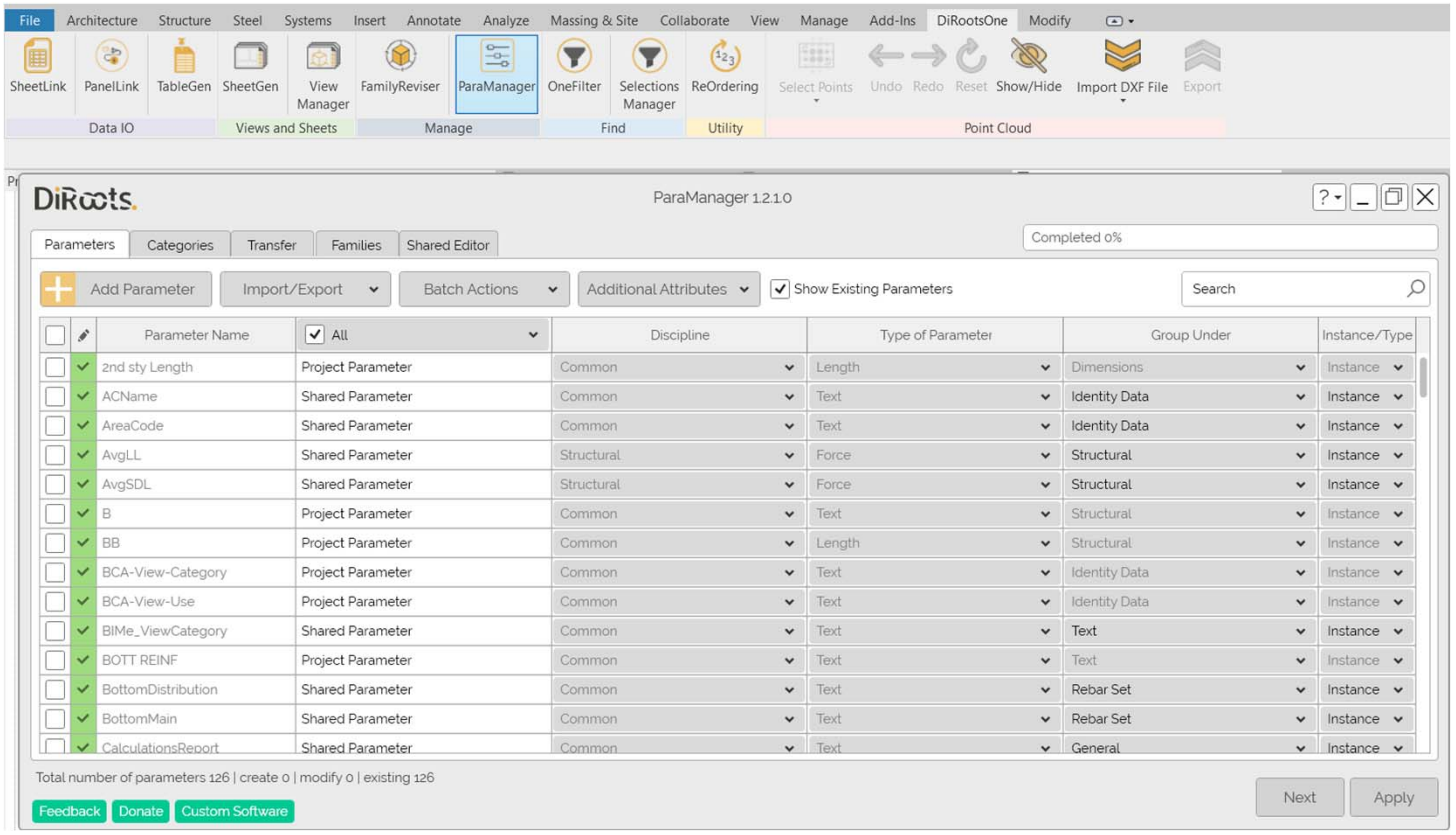
Project Parameters

Only exists within Revit Project, not Revit family e.g.
Project Reference: Axxxx-xxx
Project Title: Proposed xxx

Reviewing Parameters – Pre-DiRootsOne DS



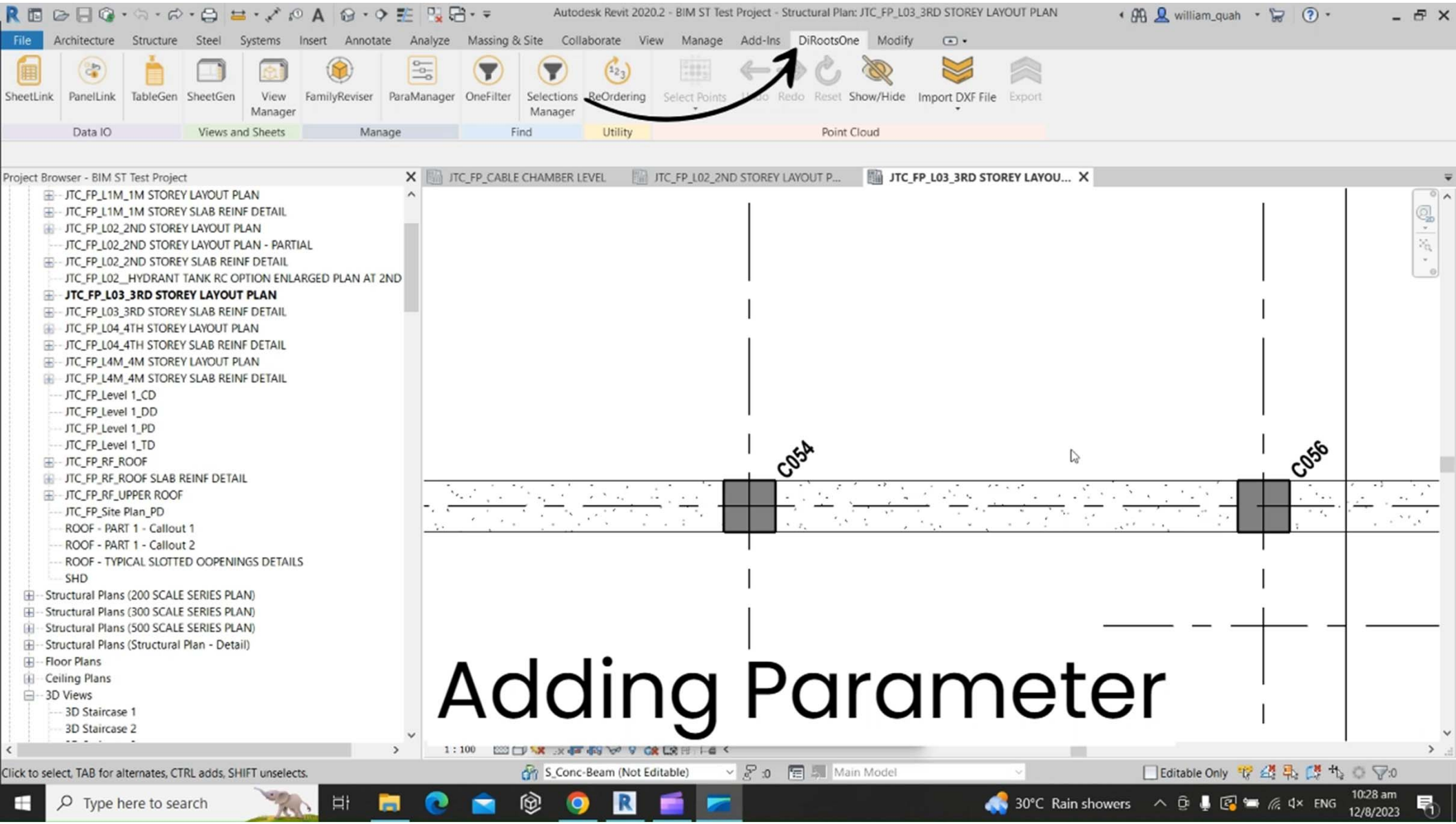
Reviewing Parameters –DiRootsOne



DiRootsOne is a free Revit plugin which has automation functions in simple interfaces.

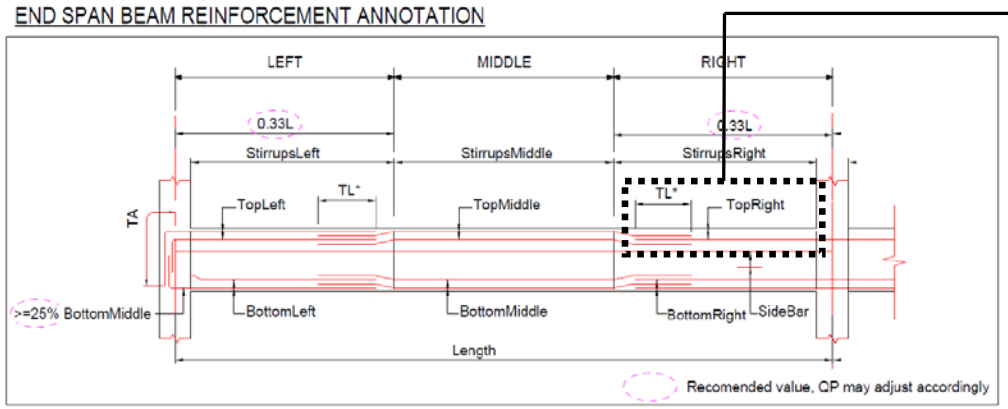
Creation of Shared Parameters is very easy once Engineer and modeller determine attributes of new parameter

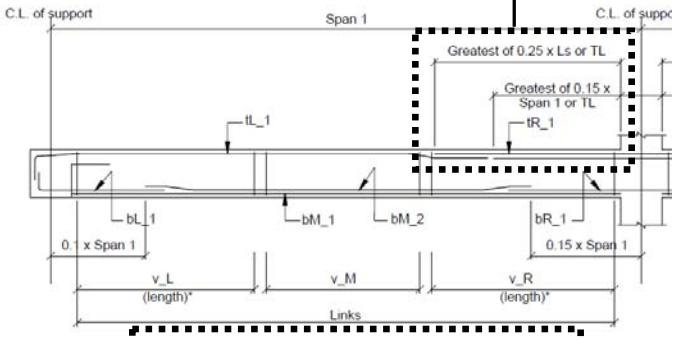
Once done for 1 project, Shared Parameters can be exported to Text file for future projects


Autodesk Revit 2020.2 - BIM ST Test Project - Structural Plan: JTC_FP_L03_3RD STOREY LAYOUT PLAN
william_quah
File
Architecture
Structure
Steel
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
DiRootsOne
Modify
SheetLink
PanelLink
TableGen
SheetGen
View Manager
FamilyReviser
ParaManager
OneFilter
Selections Manager
ReOrdering
Select Points
Undo
Redo
Reset
Show/Hide
Import DXF File
Export
Data IO
Views and Sheets
Manage
Find
Utility
Point Cloud
Project Browser - BIM ST Test Project
JTC_FP_L1M_1M STOREY LAYOUT PLAN
JTC_FP_L1M_1M STOREY SLAB REINF DETAIL
JTC_FP_L02_2ND STOREY LAYOUT PLAN
JTC_FP_L02_2ND STOREY LAYOUT PLAN - PARTIAL
JTC_FP_L02_2ND STOREY SLAB REINF DETAIL
JTC_FP_L02__HYDRANT TANK RC OPTION ENLARGED PLAN AT 2ND
JTC_FP_L03_3RD STOREY LAYOUT PLAN
JTC_FP_L03_3RD STOREY SLAB REINF DETAIL
JTC_FP_L04_4TH STOREY LAYOUT PLAN
JTC_FP_L04_4TH STOREY SLAB REINF DETAIL
JTC_FP_L4M_4M STOREY LAYOUT PLAN
JTC_FP_L4M_4M STOREY SLAB REINF DETAIL
JTC_FP_Level 1_CD
JTC_FP_Level 1_DD
JTC_FP_Level 1_PD
JTC_FP_Level 1_TD
JTC_FP_RF_ROOF
JTC_FP_RF_ROOF SLAB REINF DETAIL
JTC_FP_RF_UPPER ROOF
JTC_FP_Site Plan_PD
ROOF - PART 1 - Callout 1
ROOF - PART 1 - Callout 2
ROOF - TYPICAL SLOTTED OOPENINGS DETAILS
SHD
Structural Plans (200 SCALE SERIES PLAN)
Structural Plans (300 SCALE SERIES PLAN)
Structural Plans (500 SCALE SERIES PLAN)
Structural Plans (Structural Plan - Detail)
Floor Plans
Ceiling Plans
3D Views
3D Staircase 1
3D Staircase 2
JTC_FP_CABLE CHAMBER LEVEL
JTC_FP_L02_2ND STOREY LAYOUT P...
JTC_FP_L03_3RD STOREY LAYOU...
C054
C056
Adding Parameter
1 : 100
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
S_Conc-Beam (Not Editable)
Main Model
Editable Only
Type here to search
30°C Rain showers
ENG
10:28 am
12/8/2023

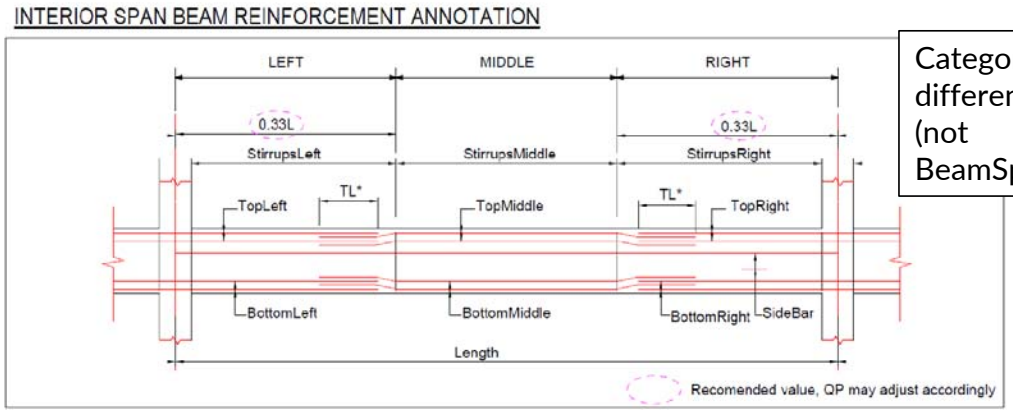
Issues with Revising Typical Details

Cannot directly adopt CX as there is no differentiation in bar length and hence cannot be used for tender/ construction



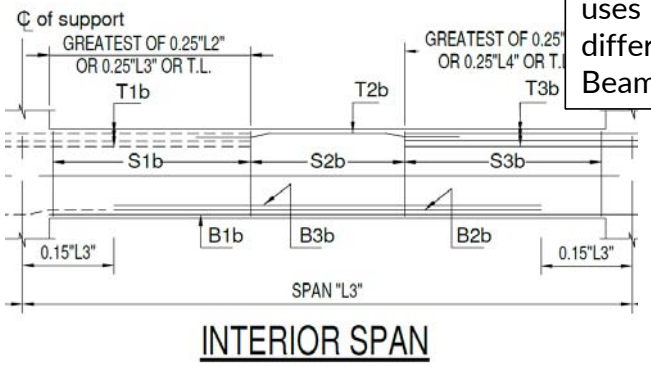


Left End Span - Simply Supported End {L_End (S)}



Categorizations are different from CX (not using BeamSpanType)

Example below uses lettering to differentiate BeamSpanType



Corenet X details

Sample Typical Details

Adjust Typical Detail to Allow Conversion to CX

Adjust Beam Name

Beam Mark is formed by 2 parameters:

Beam & SpanNo. Mark = Level + Vert/Horizontal + Beam + -SpanNo

E.g. 1H01-1

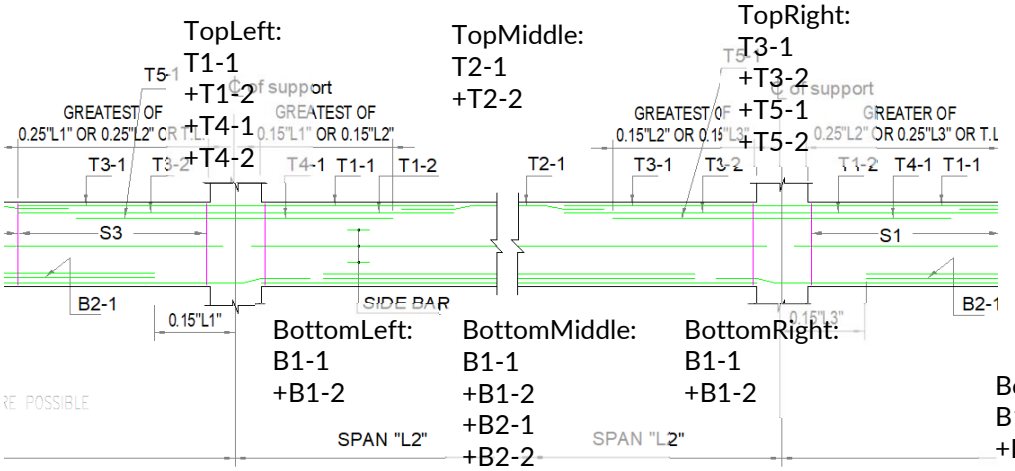
Hence if BeamSpanType is Cantilever and SpanNo is 1, beam is left cantilever. SpanNo>1, beam is right cantilever

Adjust Beam Reinforcement

T1 & T4 is always on top left, T3 & T5 always on top right, T2 always on top middle

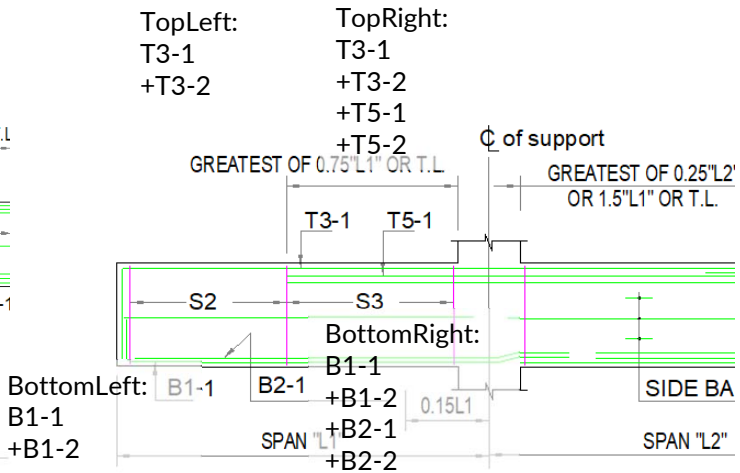
B1 is always longer bottom bar being lapped, B2 is always shorter bottom bar

With these rules and BeamSpanType & Simple/Fixed parameters, a DS can be written to convert.



INTERIOR SPAN

BeamSpanType: Interior
Simple/Fixed: -



CANTILEVER SPAN (LHS)

BEAM SPAN TYPE: CANTILEVER
Simple/Fixed: -

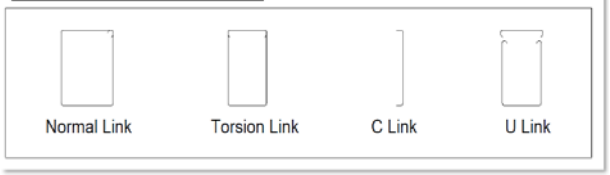
Partial Adoption of CX parameters

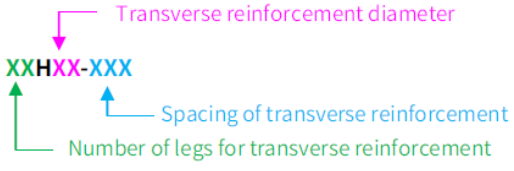
Using BeamSpanType and adding Simple/Fixed parameter, Beam schedule is simplified to be applicable for all beam types

Beam Mark	Beam Size b	Beam Size h	Approx. Length (mm)	Simple/Fixed	BeamSpanType	B1-1	B1-2	B2-1	B2-2	T1-1	T1-2	T2-1	T2-2	T3-1	T3-2	T4-1	T4-2	T5-1	T5-2	S1	S2	S3	NoOfStirrups	OuterStirrup Type	InnerStirrup Type	SideBar
2V01-1	250	1000	2175		Single Cantilever	2H25								2H25	2H25						H10-200	H10-200	1	Normal		3H13-200
2V02-1	800	1000	8500	S	End	6H20	-	-	-	6H20	-	-	-	6H20	-					H10-200	H10-300	H10-200	2	Normal	U	3H16-200
2V02-2	800	1000	4700	S	End	6H20	-	-	-	6H20	-	-	-	6H20	-					H10-200	H10-300	H10-200	2	Normal	U	3H16-200
2V03-1	250	800	2325	S	Single	2H16	-	-	-	2H16	-	-	-	-	-					H10-200	H10-300	H10-200	1	Normal		
2V04-1	400	800	8550	S	End	3H25	3H25	3H25	-	3H16	-	-	-	3H32	-					H10-200	H10-300	H10-200	1	Normal		
2V04-2	400	800	4700	-	Interior	3H25	-	-	-	3H32	-	3H20	-	3H25	-					H10-200	H10-300	H10-200	1	Normal		
2V04-3	400	800	2500	-	Cantilever	3H16	-	-	-	3H25	-	-	-	-	-					-	H10-300	H10-200	1	Normal		
2V05-1	400	800	5376	S	Single	3H20	-	-	-	3H20	-	-	-		-					H10-200	H10-300	H10-200	1	Normal		

Revised Beam Schedule

DEFINITION OF STIRRUPS TYPE





13	SideBar	Text	When required / relevant	-	Yes	H13-250
14	StirrupsLeft	Text	RC beam	-	Yes	4H13-300
15	StirrupsMiddle	Text	RC beam	-	Yes	4H13-300
16	StirrupsRight	Text	RC beam	-	Yes	4H13-300
17	StirrupsTypeLeft	Text	RC beam	-	Yes	Refer to list^
18	StirrupsTypeMiddle	Text	RC beam	-	Yes	Refer to list^
19	StirrupsTypeRight	Text	RC beam	-	Yes	Refer to list^

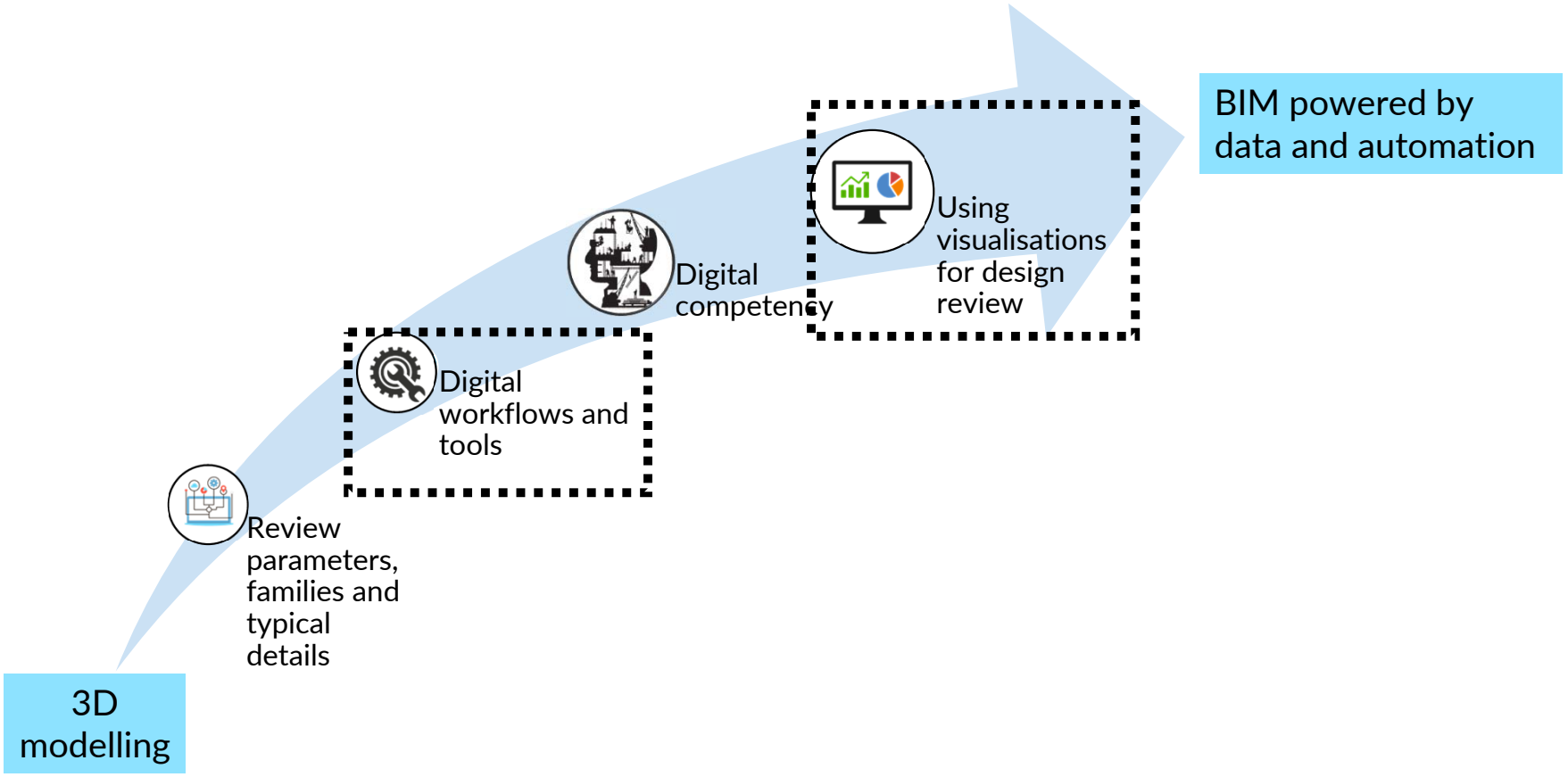
Part of RC Beam CX parameters and definitions

Did not adopt CX parameters for beam links Tender/Construction framework as it hindered automation. Current framework allows for:

- Ability to copy and paste data quickly across multiple beams
- Automated filling in of NoOfStirrups (not legs) based on beam width
- Automated filling in of OuterStirrupType/ InnerStirrupType for all beams regardless of beam width
- Better design review to filter out special beams in Torsion

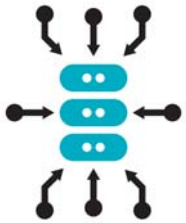
DS can be written to combine to CX format

Steps to Implement Data Approach



General Idea of Workflows

Automated naming of each element with unique name



Automated filling in of attributes to aid Engineer in data input

Beams → BeamSpanType
Slabs → SlabType & MainBarDirection
Walls → Loadbearing
Piles & Pile Caps → Column Mark, PileCutOffLevel

Export and import data and run DS to adjust geometry

Visualisations on BIM model or Dashboards for reviews

Semi-automated population of remaining MCR/ IFC-SG data and export as IFC

Video of Digital Workflow of Design Tools and Visualisations using Data for Design Review