INTEGRATING REVIT AND EXCEL FOR ESTIMATE / BQ PRODUCTION

presented by
Sr. TANG Ki-cheung
FHKIS RPS(QS) FSZCEA MHKIVM
Director of K C Tang Consultants Ltd.
Quantity Surveyors . Construction Cost and Contract Consultants Ltd.

at
INTERNATIONAL WORKSHOP FOR
QS BIM EDUCATION & TRAINING CONTENT DEVELOPMENT
organized by
BIM Technical Committee, QS Division, Royal Institution of Surveyors, Malaysia
on 20 February 2014 (Thursday) at Nippon Paint (Malaysia) Sdn. Bhd., Selangor, Malaysia

Biography

Mr. Tang is a qualified professional quantity surveyor. He has over 37 years professional quantity surveying experience, handled over 670 projects in Hong Kong and Mainland China, facilitated or co-facilitated about 20 partnering / value management workshops, delivered speeches at over 30 professional and technical seminars and pre-qualification structured training events. He drafted the Standard Form of Contract for Maintenance and Renovation Works First Edition 2013. He has served as a council member in many institutions in Hong Kong, including the Hong Kong Institute of Surveyors (HKIS) since 1998 and the Hong Kong Institute of Value Management since 2010. He was appointed as the Chairman of the BIM Sub-Committee under HKIS's Quantity Surveying Divisional Council since 2012 and as the Chairman of the Organizing Committee for the International QS BIM Conference 2013 Hong Kong,

Abstract

The standard parameters provided by Revit are not ready enough for producing quantities for estimates or bills of quantities. This paper shows an investigation on how to code the parametric building elements in Revit in a self-explanatory manner simple yet sufficient for generation of dimensions and quantities which are auditable for production of estimates or bills of quantities using Excel.

Keywords

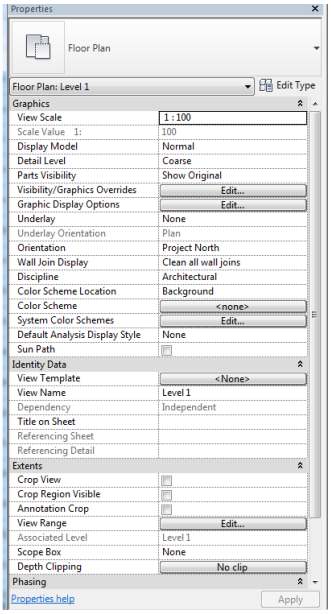
Revit, Excel, parameters, schedules, quantities, estimate, BQ.

1. Elements

Each building block or object making up a Revit model is called an element. Each element has its own properties with values. Each of these properties is called a parameter

Elements are grouped by Family > Type > Instance. An instance is a single element. Each element shares the same Family Parameters which can be overridden by Type Parameters which can be overridden by Instance Parameters.

The parameters can be viewed and some may be edited through a Properties window.



2. Schedules / Quantities

However, it will soon be discovered that it would be better to view and edit a group of elements presented in tabular format, i.e. schedules.

<Floor Schedule>

A	B	C	D	E	F	G	H	I	J	K	L
Level	Mark	Family	Type	QS Tag	m3	m2	m	Count	Perimeter	Area	Volume
Level 2	2S1	Floor	SL-C30-150	H3.5-5		200.00		1	60000	200.00	30.000
Level 2	2S2	Floor	SL-C30-130	H3.5-5		51.50		1	30600	51.50	6.695
Grand total: 2						251.50		2	90600	251.50	36.695

<Wall Schedule>

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
QS Floor	Mark	Family	Type	QS Tag	m3	m2	m	Count	Length	Width	Area	Volume	QS Mean Area	Mean Area / Lengt
Level 1		Basic Wall	IW-BLK-100			12.13	4550	1	4550	100	12.13	1.213	12.13	2665
Level 1		Basic Wall	EW-C20-125			9.69	4250	1	4250	125	9.69	1.212	9.69	2281
Level 1		Basic Wall	EW-C20-125			11.93	4400	1	4400	125	11.93	1.491	11.93	2710
Level 1		Basic Wall	EW-C20-125			11.93	4250	1	4250	125	11.93	1.491	11.93	2806
Level 1		Basic Wall	EW-C20-125			13.12	4100	1	4100	125	13.12	1.640	13.12	3200
Level 1		Basic Wall	EW-C20-125			12.41	4400	1	4400	125	12.41	1.551	12.41	2819
Level 1		Basic Wall	EW-C20-125			13.07	4550	1	4550	125	13.07	1.634	13.07	2873
Level 1		Basic Wall	EW-C20-125			12.83	4625	1	4625	125	12.83	1.604	12.83	2774
Level 1		Basic Wall	EW-C20-125			14.51	5150	1	5150	125	14.51	1.814	14.51	2818
Level 1		Basic Wall	EW-C20-125			14.30	5000	1	5000	125	14.30	1.787	14.30	2859
Level 1	WA1	Basic Wall	WA-C35-400	SL150-Edge		15.70	4850	1	4850	400	16.27	6.278	15.70	3236
Level 1	WA2	Basic Wall	WA-C35-300	SL150-Edge		17.90	4650	1	4650	300	19.25	5.371	17.90	3850
Level 1	WA2A	Basic Wall	WA-C35-300	SL150		2.19	658	1	658	300	2.77	0.658	2.19	3338
Level 1	WA3	Basic Wall	WA-C35-300	SL150		17.71	4800	1	4800	300	17.71	5.313	17.71	3690
Level 1	WA4	Basic Wall	WA-C35-300	SL150-Edge		16.98	4700	1	4700	300	18.13	5.094	16.98	3612
Level 1	WA5	Basic Wall	WA-C35-300	SL150		16.14	4800	1	4800	300	17.30	4.843	16.14	3363
Level 1	WA6	Basic Wall	WA-C35-300	SL150		18.10	4788	1	4788	300	19.25	5.429	18.10	3780
Level 1	WA7	Basic Wall	WA-C35-300	SL150		18.10	4788	1	4788	300	19.25	5.428	18.10	3780
Level 1	WA8	Basic Wall	WA-C35-300	SL150-Edge		38.50	9875	1	9875	300	38.50	11.550	38.50	3899
Grand total: 19						287.22	89183	19	89183	4025	294.35	65.399	287.22	60354

<Structural Column Schedule>

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Base Level	Column Location Mark	Family	Type	QS Tag	m3	m2	m	Count	QS App Slab Tk	Top Level	Length	QS Width	QS Depth	Volume	Vol / (Wi x Dp)
Level 1	B-2	CL-C40	450 x 600				4000	1	150	Level 2	4000	450	600	1.040	3850
Level 1	C-1	CL-C40	600 x 750	SL150-EdgeL			4000	1	150	Level 2	4000	600	750	1.733	3850
Level 1	C-2	CL-C40	450 x 600	SL150			4000	1	150	Level 2	4000	450	600	1.040	3850
Level 1	C-3	CL-C40	450 x 600	SL150			4000	1	150	Level 2	4000	450	600	1.040	3850
Level 1	C-4	CL-C40	450 x 600	SL150-EdgeS			4000	1	150	Level 2	4000	450	600	1.040	3850
Level 1	D-1	CL-C40	600 x 750	SL130-Corner			4000	1	130	Level 2	4000	600	750	1.742	3870
Level 1	D-2	CL-C40	600 x 750	SL130-EdgeS			4000	1	130	Level 2	4000	600	750	1.742	3870
Level 1	D-3	CL-C40	600 x 750	SL130-Corner			4000	1	130	Level 2	4000	600	750	1.742	3870
Level 1	D-4	CL-C40	600 x 750				4000	1	0	Level 2	4000	600	750	1.800	4000
Level 1	D-5	CL-C40	600 x 750				4000	1	0	Level 2	4000	600	750	1.800	4000
Grand total: 10							40000	10			40000			14.715	38860

<Structural Framing Schedule>

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Reference Level	Mark	Family	Type	QS Tag	QS m3	QS m2	QS m	Cou	App SL Tk	Length	Cut Lengt	QS Widt	QS Dep	Volume
Level 2	2B1	BM-C30	400 x 800	SL130			4100	1	130	5000	4100	400	800	1.099
Level 2	2B2	BM-C30	400 x 800	SL130			4400	1	130	5000	4400	400	800	1.179
Level 2	2B3	BM-C30	400 x 800	I			4400	1	0	5000	4400	400	800	1.408
Level 2	2B4	BM-C30	400 x 800	I			4100	1	0	5000	4100	400	800	1.312
Level 2	2B5	BM-C30	400 x 800	SL150			4175	1	150	5000	4175	400	800	1.086
Level 2	2B6	BM-C30	400 x 800	SL150			4550	1	150	5000	4550	400	800	1.183
Level 2	2B7	BM-C30	400 x 800	SL150-Edge			4550	1	150	5000	4550	400	800	1.183
Level 2	2B8	BM-C30	400 x 800	SL150			4475	1	150	4850	4475	400	800	1.164
Level 2	2B9	BM-C30	300 x 600	SL150			1380	1	150	1530	1380	300	600	0.186
Level 2	2B10	BM-C30	300 x 600	SL150			2375	1	150	2750	2375	300	600	0.321
Level 2	2B11	BM-C30	400 x 800	SL150			4775	1	150	5150	4775	400	800	1.242
Level 2	2B12	BM-C30	400 x 800	SL150			4700	1	150	5000	4700	400	800	1.222
Level 2	2B13	BM-C30	400 x 800	SL150-Edge			5000	1	150	5150	5000	400	800	1.300
Level 2	2B14	BM-C30	400 x 800	SL150-Edge			4700	1	150	5000	4700	400	800	1.222
Level 2	2B15	BM-C30	400 x 800	SL130-Edge			4250	1	130	5000	4250	400	800	1.139
Level 2	2B16	BM-C30	400 x 800	SL150-Edge			4250	1	150	4775	4250	400	800	1.105
Level 2	2B17	BM-C30	400 x 800	SL130			4250	1	130	4875	4250	400	800	1.139
Level 2	2B18	BM-C30	400 x 800	SL150			4400	1	150	5050	4400	400	800	1.144
Level 2	2B19	BM-C30	400 x 800	SL130-Edge			4250	1	130	4875	4250	400	800	1.139
Level 2	2B20	BM-C30	400 x 800	SL150			4400	1	150	4950	4400	400	800	1.144
Level 2	2B21	BM-C30	400 x 800	I			4250	1	0	4875	4250	400	800	1.360
Level 2	2B22	BM-C30	400 x 800	SL150			4387	1	150	4950	4387	400	800	1.141
Level 2	2B23	BM-C30	400 x 800	I			4237	1	0	4775	4237	400	800	1.356
Level 2	2B24	BM-C30	250 x 350	SL150			4400	1	150	4800	4400	250	350	0.220
Level 2	2B25	BM-C30	250 x 350	SL150			4600	1	150	5000	4600	250	350	0.230
Level 2	2B26	BM-C30	250 x 350	SL150			4600	1	150	5000	4600	250	350	0.230
Level 2	2B27	BM-C30	250 x 350	SL150			4500	1	150	4850	4500	250	350	0.225
Level 2	2B28	BM-C30	400 x 800	SL150			4000	1	150	4800	4000	400	800	1.040
Grand total: 28							118455	28		133005	118455	10400	20200	27.717

<Door Quantities>

A	B	C	D	E	F	G	H	I	J	K	L	M
Level	Mark	Door Type	Type	QS Tag	m3	m2	m	Count	Family	Width	Height	Thickness
Level 1	1	D1	1830 x 2134mm	EW-CON-125				1	M_Double-Glass 1	1830	2134	51
Level 1	2	D2	0915 x 2134mm	IW-BLK-100				1	M_Single-Flush	915	2134	51
Level 1	3	D2	0915 x 2134mm	WA-CON-300				1	M_Single-Flush	915	2134	51
Grand total: 3								3				

<Window Quantities>

A	B	C	D	E	F	G	H	I	J	K	L
Level	Mark	Type Mark	Type	QS Tag	m3	m2	m	Count	Width	Height	Sill Height
Level 1	1	WD1	1220 x 1220	WA-CONC-400				1	1220	1220	1100
Level 1	2	WD1	1220 x 1220	WA-CONC-400				1	1220	1220	1100
Level 1	3	WD1	1220 x 1220	EW-CONC-125				1	1220	1220	1100
Level 1	4	WD2	0610 x 1830	WA-CONC-300				1	610	1830	1100
Level 1	5	WD3	0406 x 1830	EW-CONC-125				1	406	1830	1100
Level 1	6	WD1	1220 x 1220	EW-CONC-125				1	1220	1220	1100
Level 1	7	WD1	1220 x 1220	EW-CONC-125				1	1220	1220	1100
Level 1	8	WD4	1830 x 0915	EW-CONC-125				1	1830	915	1100
Level 1	10	WD5	0915 x 1830	EW-CONC-125				1	915	1830	1100
Level 1	11	WD5	0915 x 1830	EW-CONC-125				1	915	1830	1100
Grand total								10			

3. Ocean of data

Quantities of materials and work can be obtained from the values of the parameters in a Revit model.

However, there are so many parameters provided by a Revit model. The QS has to understand what they mean before they can be properly used. Revit's help pages do not fully tell the users what the length, area and volume (which are the QS's concerns) actually represent. The users have to do some trials before getting some, perhaps not yet full, understanding of their representation under different scenarios.

Only with such understanding that the QS can be capable of asking the modeller in the first place to model in the desired manner to give the desired outcome, but there is no guarantee that the model eventually received will be error free. Actually, it is almost impossible for it to be error free.

The QS has to examine whether the model has been modelled in the desired manner before the data extracted from it can be properly used, and go back to ask the modeller to adjust the modelling method in general or the model in particular in order to give the desired length, area and volume.

Assuming that the modeler is a nice person and is pleased to entertain, re-examination by the QS is still required after the modeller's correction. This seems to be a laborious exercise.

The solution would be for the QS to extract the minimum essential information from the model leaving the majority untouched, and carry out further processing in a transparent and easily auditable manner, e.g. using Excel.

4. Yet lacking the right boats

Revit has a scheduling function to present the parameters and their values. However, not all the parameters in a Revit model can appear in the schedules, unless a third party software is used to extract the unexposed parameters.

In spite of there being so many data, the dimensional and quantity data required by the QS for quantity take-off and billing are not readily available from the model or are not available according to the desired method of measurement, e.g. no formwork area, no information about the adjacent elements, no information about the height from below, overlapping quantities at junctions, etc.

Luckily, Revit allows users to add new parameters to contain additional data.

The solution would be for the QS to add his own parameters and data, but leaving other people's data untouched.

One can create many different kinds of schedules for different families of elements, but it would be a laborious task to transfer the data at different locations on different schedules to the Estimate or Bills of Quantities, and this whole exercise is error prone.

The solution would be to extract only the minimum sub-sets of the essential data from the schedules and keep the format of such sub-sets consistent.

Furthermore, the schedules as given above only give one total value per column. If one would like to get the sub-totals by Type, the schedule rows would need to be sorted and grouped by Type. This would mean that the schedule rows would not be in the Level and Mark sequence which is better for tracing. It would also be difficult to transfer the sub-totals dispersed over the schedule to other places like Excel.

Revit schedules can have calculated columns but the functions that can be used in the calculation are very limited. For example, it cannot combine the value of two texts.

The solution would be to use Excel or other third party software to manipulate the data.

Establishing a unified coding system applicable to the whole company such that the data can be classified, compared on the same basis, shared and re-used appears to be a good idea. However, the codes may not be comprehensive enough, may not be easily memorised, and most of the time people would code incorrectly. A good coding system seems to be always unattainable. The idea of coding for company-wide use is not really cost effective.

The solution would be to code the data in a self-explanatory manner simple yet sufficient for use on a project or team basis. If a particular project needs to be compared with other projects, re-code it on an as-needed basis.

5. Demonstration

The following demonstrates that the codes though simple should be sufficient enough to represent the concrete column items.

	COLUMNS		
	Reinforced concrete 40MPa in		
CL-C40	Column	13	m3
	Formwork to		
CL-FWK	Side of column	89	m2

Furthermore, instead of requiring the model to give the concrete volume and formwork area of each column first before summing up, it would be simpler just to get the total length of columns of the same cross-sectional size first (4 m of 450 x 600 mm column in the following example) and then calculate the total concrete volume and formwork area in one go. This would reduce the number of dimension lines substantially.

Column concrete	0.00						
CL-C40-450 x 600-	4.00	0.45	0.60				CL-C40
CL-C40-450 x 600-	4.00	0.45		2.00			CL-FWK
CL-C40-450 x 600-	4.00		0.60	2.00			CL-FWK

Similarly, if doors and windows are to be billed by number, then one does not need to require the model to give the detailed component quantities of the doors. If one would need to measure the door components in detail, instead of requiring the model to give the component quantities door by door (which requires high skill in building up the door model first), it would be simpler just to get the total number of each door type, measure the component quantities of one door and times them by the total number. If a fuller BQ description is required, one would need to refer to the model or drawing in any case.

	DOORS		
D1-1830 x 2134	Door type D1; 1800 x 2100 mm high	1	Nr
D2-0915 x 2134	Door type D2; 900 x 2100 mm high	2	Nr
	WINDOWS		
WD1-1220 x 1220	Window type WD1; 1200 x 1200 mm high	5	Nr
WD2-0610 x 1830	Window type WD2; 600 x 1800 mm high	1	Nr
WD3-0406 x 1830	Window type WD3; 400 x 1800 mm high	1	Nr
WD4-1830 x 0915	Window type WD4; 1800 x 900 mm high	1	Nr
WD5-0915 x 1830	Window type WD5; 900 x 1800 mm high	2	Nr

The following demonstrates that only the following limited sub-set of data needs to be extracted from a Revit model to an Excel worksheet called “Primary”:

| Floor | Mark | Family | Type | QS Tag | m3 | m2 | m | Nr |

Seq	Floor	Mark	Family	Type	QS Tag	m3	m2	m	Nr	Short Description	Unit	Row Qty
1	**Dummy**				Seed row NOT TO BE DELETED				1.00	--Seed row NOT TO BE DELETED	Nr	1.00
2	This section is for processing data exported from Revit Schedules									--		0.00
3	**Door Quantities**									--		0.00
4	Level 1	1	D1	1830 x 2134mm	EW-CON-125				1.00	D1-1830 x 2134mm-EW-CON-125	Nr	1.00
5	Level 1	2	D2	0915 x 2134mm	IW-BLK-100				1.00	D2-0915 x 2134mm-IW-BLK-100	Nr	1.00
6	Level 1	3	D2	0915 x 2134mm	WA-CON-300				1.00	D2-0915 x 2134mm-WA-CON-300	Nr	1.00
7	**Floor Schedule**									--		0.00
8	Level 2	2S1	Floor	SL-C30-150	H3.5-5		200.00		1.00	Floor-SL-C30-150-H3.5-5	m2	200.00
9	Level 2	2S2	Floor	SL-C30-130	H3.5-5		51.50		1.00	Floor-SL-C30-130-H3.5-5	m2	51.50
10	**Structural Column Schedule**									--		0.00
11	Level 1	B-2	CL-C40	450 x 600				4,000.00	1.00	CL-C40-450 x 600-	m	4.00
12	Level 1	C-1	CL-C40	600 x 750	SL150-Edge			4,000.00	1.00	CL-C40-600 x 750-SL150-EdgeL	m	4.00
13	Level 1	C-2	CL-C40	450 x 600	SL150			4,000.00	1.00	CL-C40-450 x 600-SL150	m	4.00
14	Level 1	C-3	CL-C40	450 x 600	SL150			4,000.00	1.00	CL-C40-450 x 600-SL150	m	4.00
15	Level 1	C-4	CL-C40	450 x 600	SL150-Edge			4,000.00	1.00	CL-C40-450 x 600-SL150-EdgeS	m	4.00
16	Level 1	D-1	CL-C40	600 x 750	SL130-Corn			4,000.00	1.00	CL-C40-600 x 750-SL130-Corner	m	4.00
17	Level 1	D-2	CL-C40	600 x 750	SL130-Edge			4,000.00	1.00	CL-C40-600 x 750-SL130-EdgeS	m	4.00
18	Level 1	D-3	CL-C40	600 x 750	SL130-Corn			4,000.00	1.00	CL-C40-600 x 750-SL130-Corner	m	4.00

The same format is used for all elements, so the errors in setting up ad-hoc schedules of varying formats will be greatly reduced.

6. Workflow

The actual workflow is as follows:

(a) Data → (direct measurement without using Revit) → Primary Qty → (processing) → Secondary Qty → (processing) → Estimate or BQ

(b) Data → (extraction from Revit schedules) → Primary Qty → (processing) → Secondary Qty → (processing) → Estimate or BQ

7. Primary worksheet

The table shown above is at the lower portion of the Primary worksheet for pasting in data extracted from Revit schedules.

Each line represents one element in the Revit model. Note that the items are sequenced by Floor then by Mark for easy reference.

Floor and Mark are generally available for all elements, but not always. They are included in the Primary worksheet for identification of the elements only and not for further billing, unless further classification by floor is required.

Family and Type are always available for all elements. They are essential for further processing.

QS Tag is a new parameter added to the Revit model to contain further information not sufficiently represented by Family and Type.

Short Description is a combination of Family, Type and QS Tag for further processing.

In theory, only the Qty and Unit parameters would be required. However, since Revit does not permit mixing of number, length, area and volume within a parameter, four parameters of m3 | m2 | m | Nr have been used instead. They are self-explanatory of the units they represent. The units in the Unit column on the right hand side is not extracted from the model but are entered manually for choosing which of the m3 | m2 | m | Nr values are to be put in the Row Qty column for further processing.

The formula used for Row Qty, say at Row 14, is

=IF(L14="m3",G14)+IF(L14="m2",H14)+IF(L14="m",I14/1000)+IF(L14="Nr",J14)

where L14 is the cell reference of Unit and G14, H14, I14 and J14 are the cell reference of m3, m2, m and Nr respectively. Division by 1000 is necessary because the actual unit of the m column is in mm.

Actually the top region of the Primary worksheet is very much like the horizontally set out dimension sheets with the Row Qty being the product of all Dims and Times. This is for direct measurement rather than for pasting in the data extracted from the Revit model.

The formula used for Row Qty, say at Row 6, is

=PRODUCT(E6:J6)

where E6 is the cell reference of Dim1 and J6 the cell reference of Times3.

Seq	Floor	Reference	Dim1	Dim2	Dim3	Times1	Times2	Times3	Short Description	Unit	Row Qty
1		Dummy	1.00						Seed row NOT TO BE DELETED	Dummy	1.00
2		This section is for measurement here									0.00
											0.00
										Total	1.00

The Row Qty in the upper and lower regions are called Primary Qty which are further processed like that described above for concrete column on another worksheet called “Secondary” of the same file.

8. Secondary worksheet

The Secondary worksheet is like this.

left portion

Seq	Floor	Reference	Dim1	Dim2	Dim3	Times1	Times2	Times3	Code	Unit	Row Qty
	N/A	Short Description in Primary Sheet	Primary Qty		<---- headings for the lower region, if different ---->					PrimQ Unit	
1		Seed row NOT TO BE DELETED	1.00	2.00	3.00	4.00	5.00	0.00	#Seed#	Dummy	0.00
2		Item							Item	Item	0.00
3		Site Area							Site-Area	m2	0.00
											0.00
	N/A	Short Description in Primary Sheet	Primary Qty							PrimQ Unit	
1		Seed row NOT TO BE DELETED	1.00	2.00	3.00	4.00	5.00	0.00	#Seed#	Dummy	0.00
2		**Slab concrete**	0.00							#N/A	0.00
3		Floor-SL-C30-130-H3.5-5	51.50	0.13					SL-C30-130	m2	6.70
4		Floor-SL-C30-150-H3.5-5	200.00	0.15					SL-C30-150	m2	30.00
5		**Slab formwork**	0.00							#N/A	0.00
6		Floor-SL-C30-130-H3.5-5	51.50						SL-FWK-3.5-5	m2	51.50
7		Floor-SL-C30-150-H3.5-5	200.00						SL-FWK-3.5-5	m2	200.00
8		**Column concrete**	0.00							#N/A	0.00
9		CL-C40-450 x 600-	4.00	0.45	0.60				CL-C40	m	1.08
10		CL-C40-450 x 600-SL150	8.00	0.45	0.45				CL-C40	m	1.62
11		CL-C40-450 x 600-SL150-EdgeS	4.00	0.45	0.45				CL-C40	m	0.81
12		CL-C40-600 x 750-	8.00	0.60	0.75				CL-C40	m	3.60
13		CL-C40-600 x 750-SL130-Corner	8.00	0.60	0.62				CL-C40	m	2.98
14		CL-C40-600 x 750-SL130-EdgeS	4.00	0.60	0.62				CL-C40	m	1.49
15		CL-C40-600 x 750-SL150-EdgeL	4.00	0.60	0.60				CL-C40	m	1.44
16		**Column formwork**	0.00							#N/A	0.00
17		CL-C40-450 x 600-	4.00	0.45		2.00			CL-FWK	m	3.60

right portion

Row Qty	Times Used in BQ	BQ Unit	BQ Description	Floor	Floor Level 1	Floor Level 2
0.00	0	#N/A	#N/A	0	0	0
0.00	0	#N/A	#N/A	0	0	0
0.00	0	#N/A	#N/A	0	0	0
0.00	0	#N/A	#N/A	0	0	0
0.00	0	#N/A	#N/A	0.00	0.00	0.00
0.00	0	#N/A	#N/A	0.00	0.00	0.00
6.70	1	m3	130 mm Suspended slab	0.00	0.00	6.70
30.00	1	m3	150 mm Suspended slab	0.00	0.00	30.00
0.00	0	#N/A	#N/A	0.00	0.00	0.00
51.50	1	m2	Sides and soffit of suspended slab; strutting 3.5 - 5.0 high	0.00	0.00	51.50
200.00	1	m2	Sides and soffit of suspended slab; strutting 3.5 - 5.0 high	0.00	0.00	200.00
0.00	0	#N/A	#N/A	0.00	0.00	0.00
1.08	1	m3	Column	0.00	1.08	0.00
1.62	1	m3	Column	0.00	1.62	0.00
0.81	1	m3	Column	0.00	0.81	0.00
3.60	1	m3	Column	0.00	3.60	0.00
2.98	1	m3	Column	0.00	2.98	0.00
1.49	1	m3	Column	0.00	1.49	0.00
1.44	1	m3	Column	0.00	1.44	0.00
0.00	0	#N/A	#N/A	0.00	0.00	0.00
3.60	1	m2	Side of column	0.00	3.60	0.00

The upper region of the Secondary worksheet is similar to the upper region of the Primary worksheet for simpler direct measurement which can straightly go to the Estimate or BQ without further processing like the lower region.

Further processing of the Primary Qty is done in the lower region.

A unique list of Short Descriptions in the Primary worksheet is screened out using the function of Excel and is pasted in the lower region.

By using a special formula, each of the Primary Qty here is the total of the Primary Qty of the same Short Description in the Primary worksheet without the need to sort and group the lines in the Primary worksheet in order to give group total per each Short Description (Revit's schedules must sort and group the line items in order to give group totals.) This can permit the lines in the Primary worksheet to be arranged in a more readable sequence such as by Floor then by Mark.

The special formula is actully very simple. For example, the Primary Qty at Row 14 is

=SUMIF(Primary!$K$5:$K$125,$C14,Primary!$M$5:$M$125)

where $C14 is the Short Description on the same row, Primary!$K$5:$K$125 is the range of Short Descriptions in the Primary worksheet, and Primary!$M$5:$M$125 is the range of Row Qty in the Primary worksheet. If the Short Description in the Primary worksheet matches the Short Description in the Secondary worksheet, then add the corresponding Row Qty in the Primary worksheet.

The Primary Qty's Unit should have been placed next to the Primary Qty but has been put on the righter end just to suit the upper region which is for direct measurement.

The Code will be the code of the Estimate or BQ items.

Again, the Row Qty is the product of all Dims and Times of the same row, using the "=Product()" function. They are also called Secondary Qty.

The columns like Times Used in BQ, BQ Unit, BQ Descriptions are making referece to the Estimate or BQ worksheet for error checking.

The Floor columns are for analysis of quantities by floors.

9. Estimate or BQ worksheet

The Estimate or BQ worksheet is like this.

<PROJECT>
<CONTRACT>

Short descriptions for illustration only

BILLS OF QUANTITIES
BILL NO. 2 - BUILDING
2.1 - ALL TRADES

Item		Code	Description	Qty	Unit	Rate	HK$	<Internal reference> Floor	Floor Level 1	Floor Level 2
2.1/	2.1		Reinforced concrete 35MPa in							
2.1/	2.1.1	WA-C35-300	300 mm Wall	44	m3				44	
2.1/	2.1.2	WA-C35-400	400 mm Wall	6	m3				6	
2.1/	2.2		Formwork to							
2.1/	2.2.1	WA-FWK	Side of wall	323	m2				323	
2.1/	2.2.2	WA-FWK-J&S	Jambs and soffit of wall; > 300 mm wide	7	m2				7	
2.1/	2.2.2	WA-FWK-J&S-300	Jambs and soffit of wall; 200 - 300 mm wide	9	m				9	
2.1/	2		COLUMNS							
2.1/	2.1		Reinforced concrete 40MPa in							
2.1/	2.1.1	CL-C40	Column	13	m3				13	
2.1/	2.2		Formwork to							
2.1/	2.2.1	CL-FWK	Side of column	89	m2				89	

Similar to the Primary Qty on the Secondary worksheet, by using a special formula, each of the Qty here is the total of the Secondary Qty of the same Code in the Secondary worksheet.

The special formula is in the form of

=ROUND(SUMIF(Secondary!$J$6:$J$149,$C15,Secondary!$L$6:$L$149),0)

Basically, it means that if the Code in the Secondary worksheet matches the Code in the Estimate or BQ worksheet, then add the corresponding Row Qty in the Secondary worksheet.

The Floor columns are for internal references only.

When issuing the Estimate or BQ in Excel softcopy, the formulae should be changed to values and other internal reference data should be removed with the empty columns hidden.

10. Parameters

Having briefly gone through the Excel part of the work flow, let's go back to see the Revit part of the work flow by describing parameters first.

Parameters provided by Revit are called system parameters, which cannot be changed though some permit entry of values.

There are two types of parameters which one can define at the Family, Type or Instance level:

(a) Project Parameters: can appear in schedules but not in tags, but cannot be shared by other projects and families; and

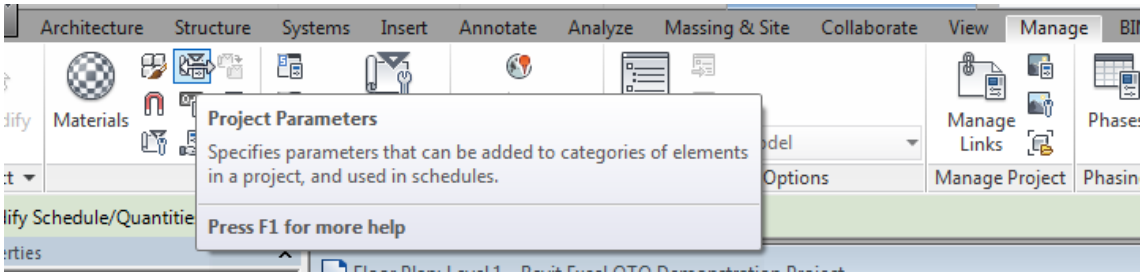
(b) Shared Parameters: can appear in schedules and tags, shared by multiple projects and families, and exported to ODBC.

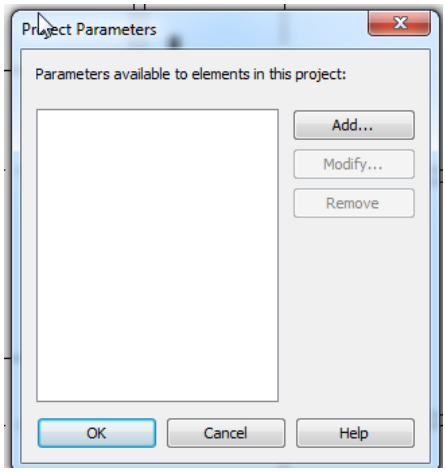
Shared Parameters appear to be more versatile and useful.

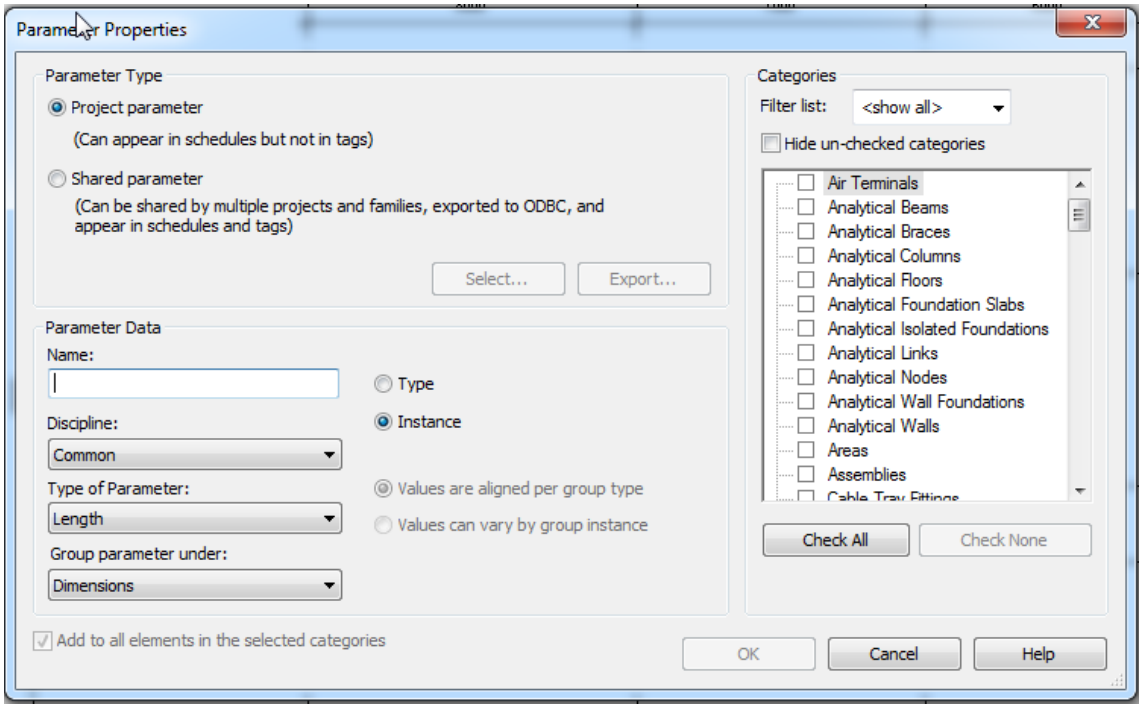
For some Families and Types, a shared parameter can be added to the properties directly. However, for others, only project parameters can be added to the properties, but a project parameter can borrow a shared parameter, so the shared parameter can still be used but indirectly.

11. Project Parameters

To add project parameters: select Manage > Settings > Project Parameters.



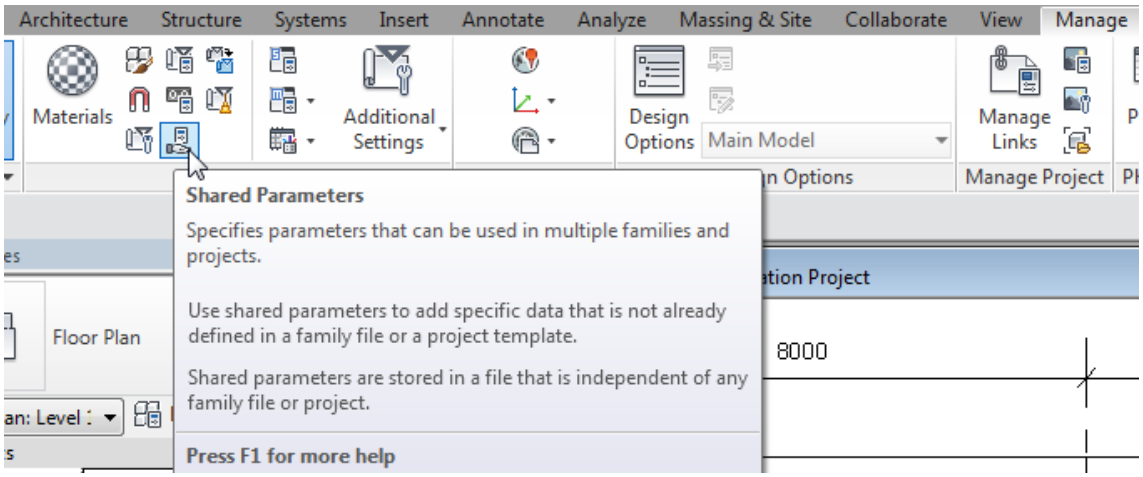


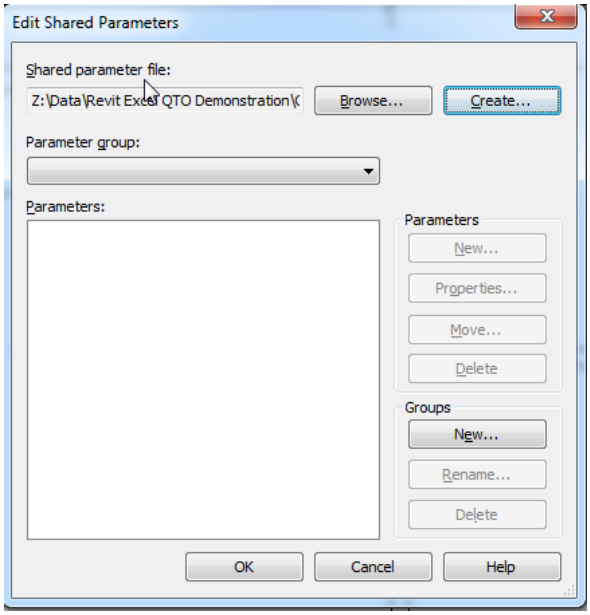


Note from the above that either a project parameter or a shared parameter can be added.

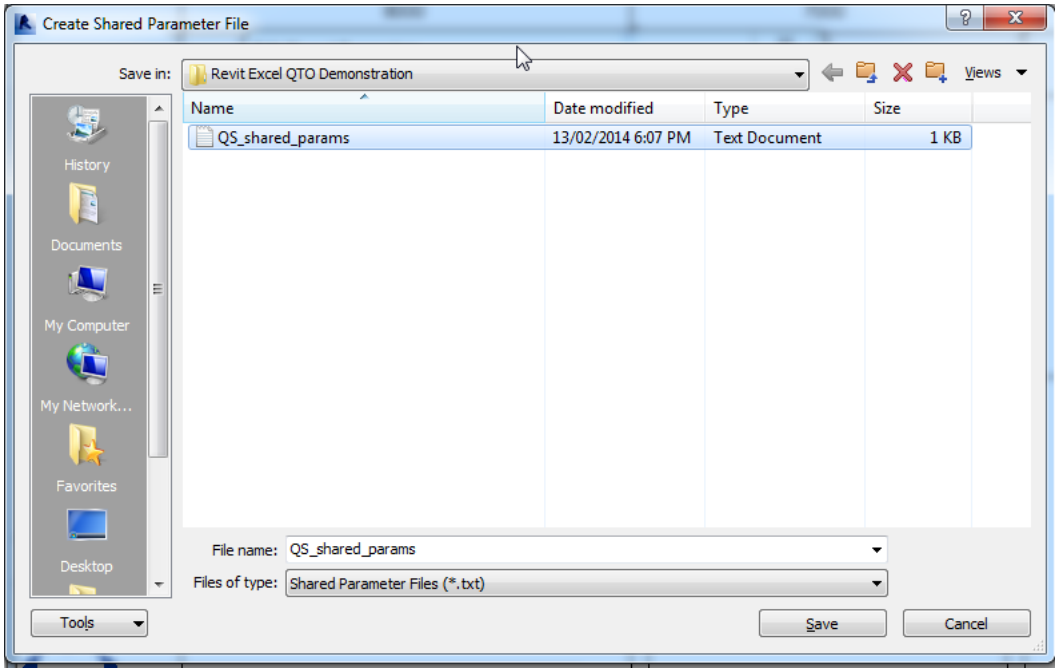
12. Shared Parameters

To add shared parameters: select Manage > Settings > Shared Parameters.



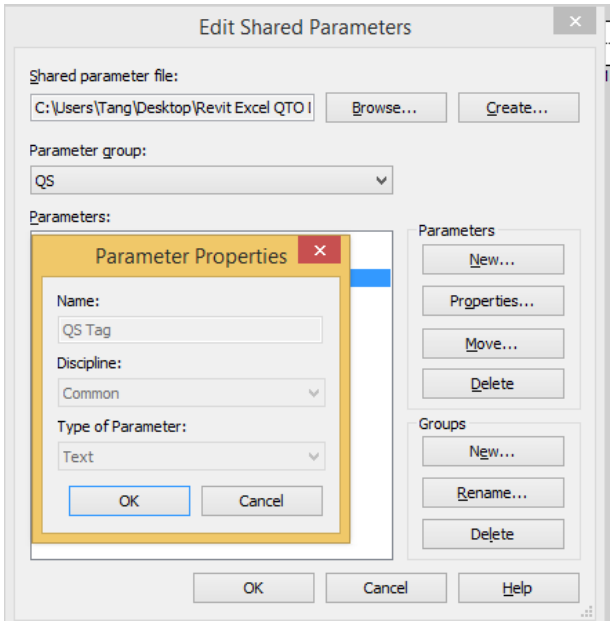


Select Create, go to a convenient folder, name a Shared Parameter file, e.g. "QS_shared_params", which is a txt file, save and return back to the above screen.



Select New under Group, name a New Parameter Group, e.g. "QS", and select OK.

Select New under Parameters, name a new parameter, e.g. “QS Tag”, select Common under Discipline, select Text under Type of Parameter, and select OK.



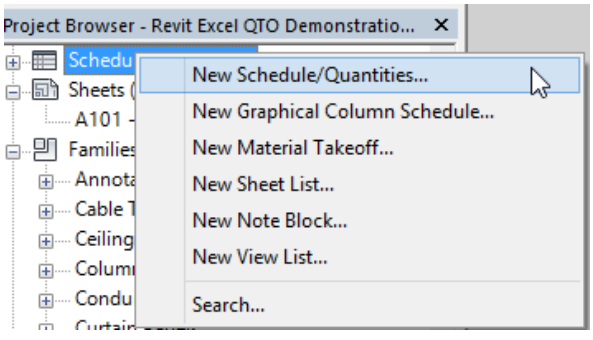
13. Creating a Revit schedule

Let's create a Revit schedule to suit the workflow, using the simplest Floor Schedule as the example.

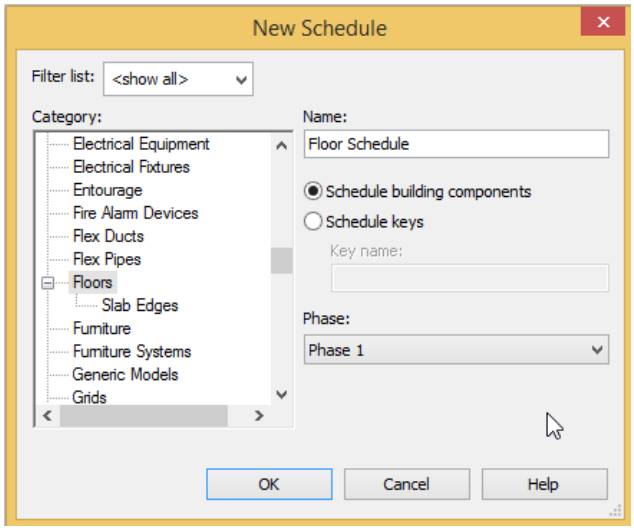
<Floor Schedule>

A	B	C	D	E	F	G	H	I	J	K	L
Level	Mark	Family	Type	QS Tag	m3	m2	m	Count	Perimeter	Area	Volume
Level 2	2S1	Floor	SL-C30-150	H3.5-5		200.00		1	60000	200.00	30.000
Level 2	2S2	Floor	SL-C30-130	H3.5-5		51.50		1	30600	51.50	6.695
Grand total: 2						251.50		2	90600	251.50	36.695

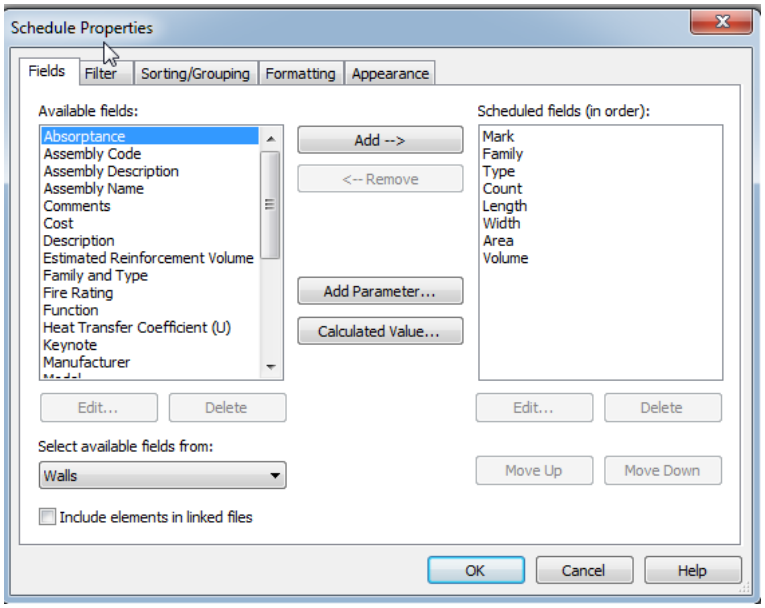
At the project browser window, right click Schedules/Quantities. Select New Schedule/Quantities.



Define as below.

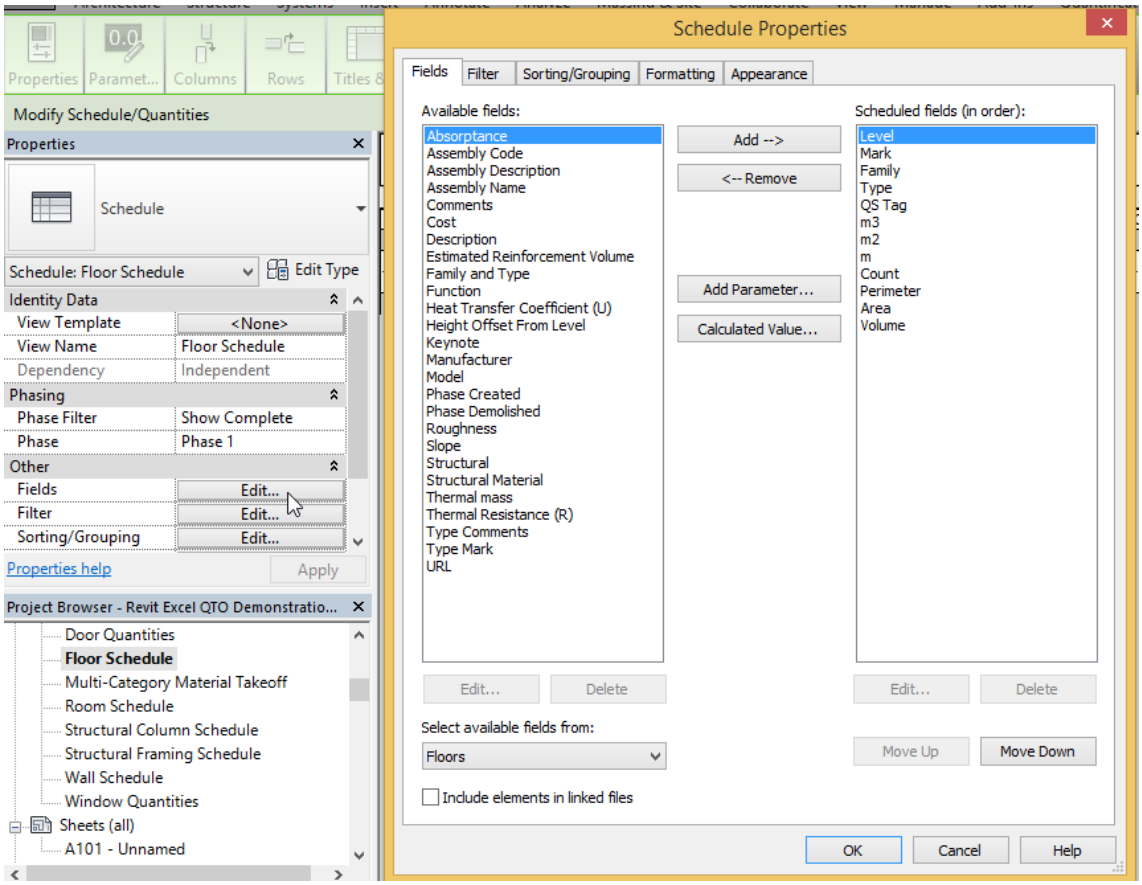


The above is defined by the following:



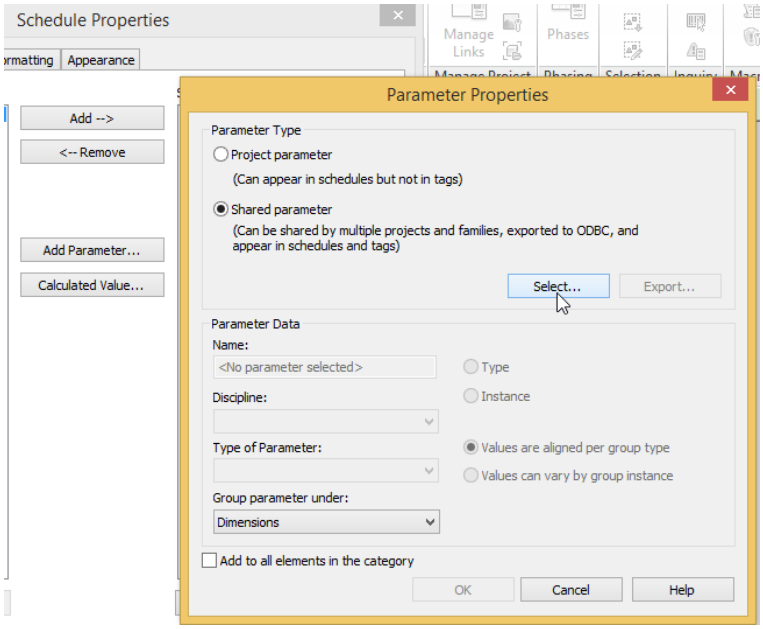
Click Edit against the Fields property on the left as indicated below to open the window on the right.

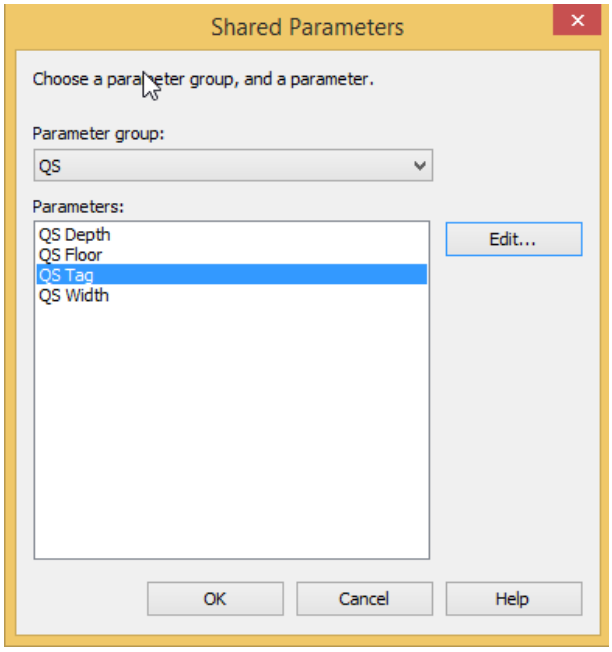
Select the desired Available fields on the left and select Add to move them to the Scheduled fields on the right. Select Move Up and Move Down as appropriate.



All the Schedule fields shown above are Available fields by default.

QS Tag is a new parameter specially added. Select Add Parameter to open the Parameter Properties window. Select Shared parameter > Select to open another window.



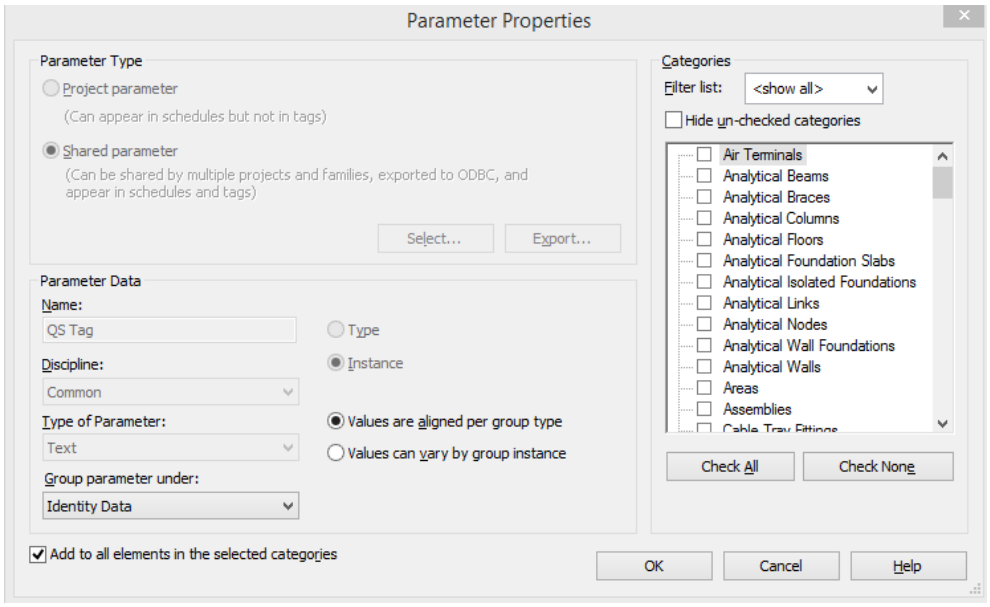


Select the Parameter Group QS if it already exists, otherwise create it as described for Shared Parameters.

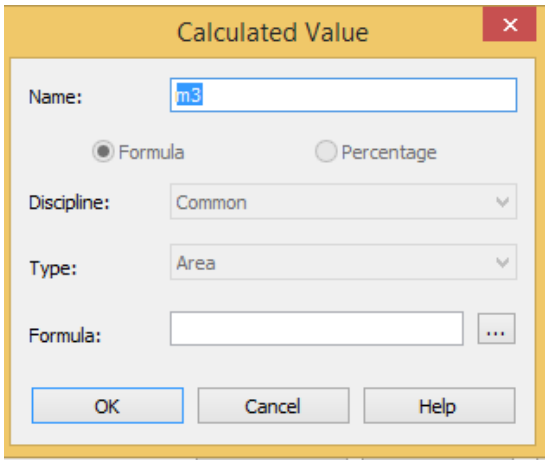
Select QS Tag if it already exists, otherwise create it as described for Shared Parameters by selecting Edit.

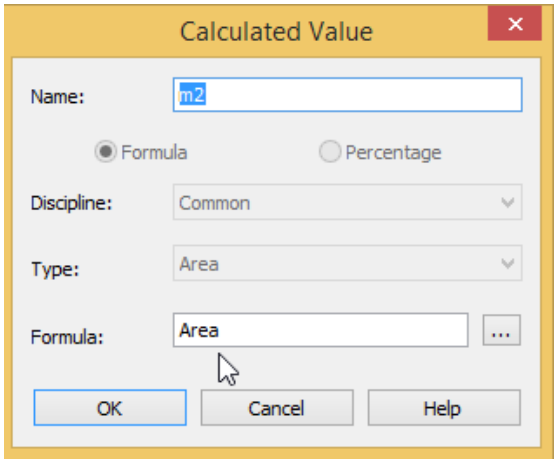
Select OK to go back to the Parameter Properties window.

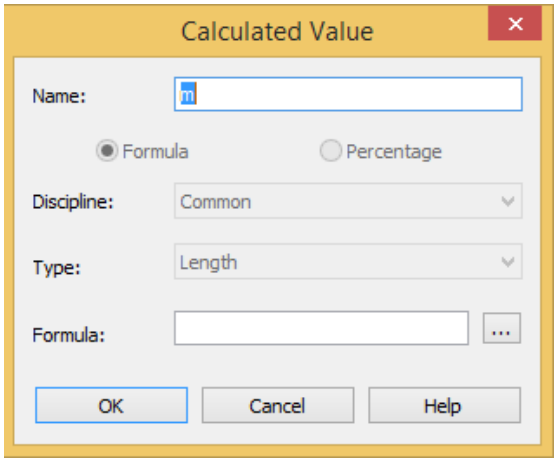
Check "Add to all elements in the selected categories" and Instance. Select Identity Data under "Group parameter under", and select OK. Move up the newly created parameter on the menu to the desired position.



“m3”, “m2”, “m” are Calculated Values, which are created by selecting Calculated Value and defining as follows:



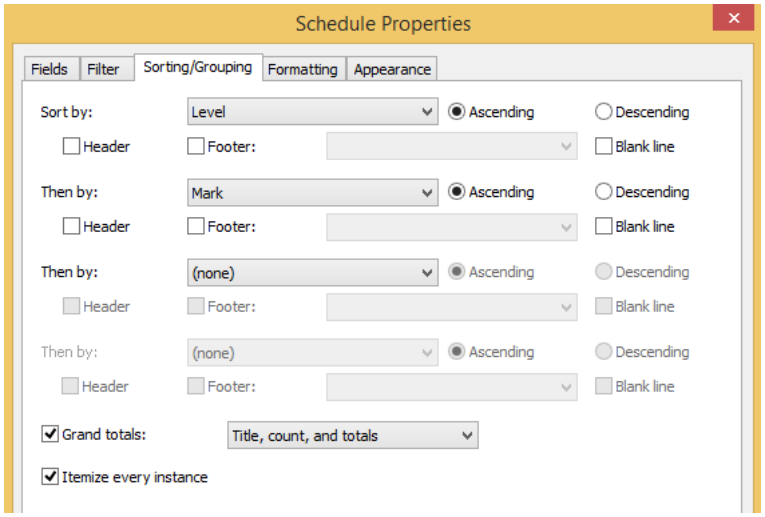




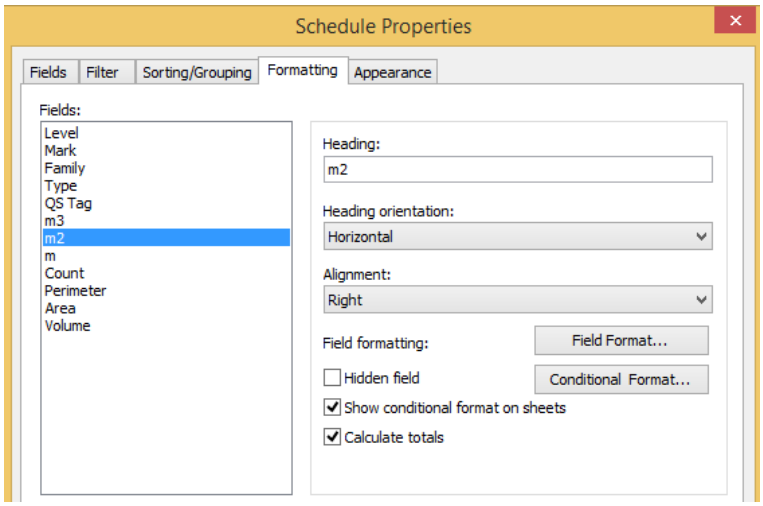
Note that only “m2” has a formula equal to Area. “m3” and “m” does not have values but are created to keep the consistent set of columns for m3 | m2 | m | Nr.

Although the Area field can be used directly, for consistency sake, “m2” is used to represent it.

The Sorting/Grouping menu is defined as follows:



In the Formating menu, numerical fields are defined to be right aligned and to calculate totals where appropriate.



The schedule creation is done.

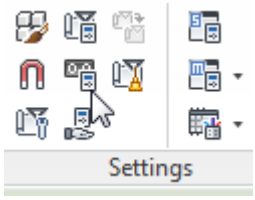
Note that only the columns from the left up to "Nr" are actually used for generating Estimate or BQ quantities, the columns to the right are for reference only.

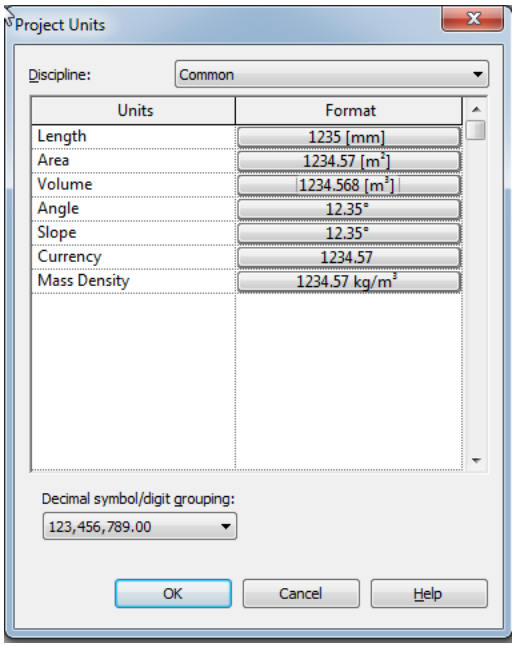
14. Project Units

The schedules show the units against numerical values by default. It would not be convenient if the numerical values are exported to Excel worksheet for further calculations because they would not be recognised as numerical values unless the units are removed

A solution would be to define two decimal places for Area and three decimal places for Volume with the units hidden, so as to make them self-explanatory without the need of units.

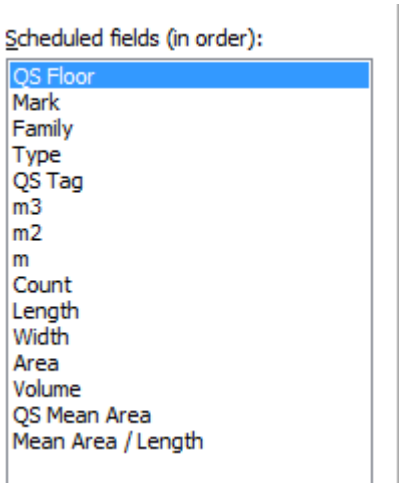
To define the project units (in metric): click Manage > Project Unit icon





15. Wall Schedules

The above Wall Schedule has the following columns:



Length, Width (i.e. thickness), Area and Volume are system parameters.

Note that Area is not always equal to the elevation areas along the centre line as explained later and would need special treatment.

Wall height is not available probably because the height can vary for a wall.

Lengths at wall ends are not available. This is still to be resolved.

Lengths around openings are not available. This is to be resolved through giving more information on the Door and Window Schedules. For blank openings, this is still to be resolved.

QS Floor is a newly added parameter because the reference of the floor where the wall stands is not available.

QS Tag is an added shared parameter, similar to that for the Floor Schedule, for giving information like the slab thickness and whether the wall is at slab edge to facilitate adjustment for slab and wall junctions.

“m3” is an empty calculated field.

“m2” is equal to Volume / Width.

“m” is equal to Length.

QS Mean Area is equal to Volume / Width also.

“Mean Area / Length” is equal to QS Mean Area / Length.

Note that both “m2” and “m” contain values for use. To distinguish between the two sets of data for use in the Excel worksheet, the Family name “Basic Wall” has been manually changed to “Basic Wall-L” in the Excel worksheet for the set using “m” as value.

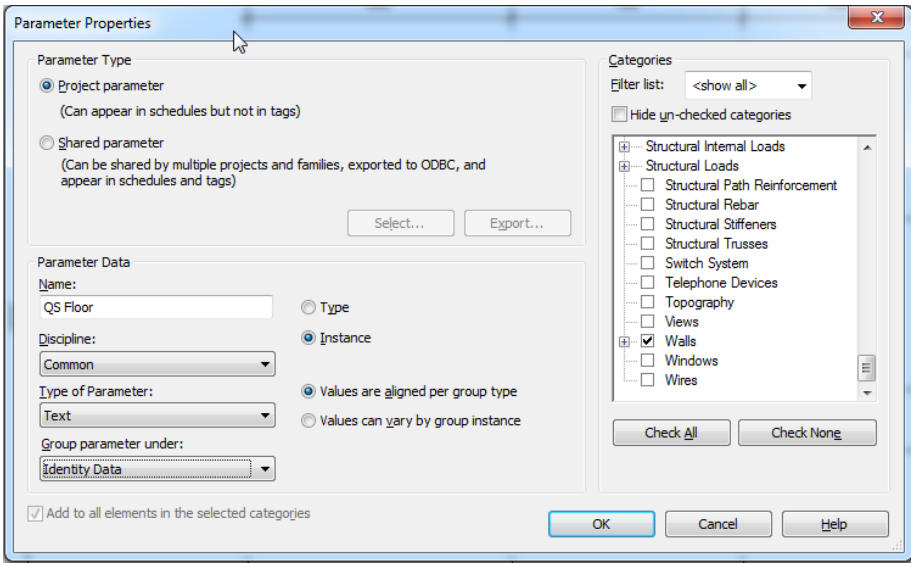
78	Level 1	WA6	Basic Wall	WA-C35-300	SL150		18.10		1.00	Basic Wall-WA-C35-300-SL150	m2
79	Level 1	WA7	Basic Wall	WA-C35-300	SL150		18.10		1.00	Basic Wall-WA-C35-300-SL150	m2
80	Level 1	WA8	Basic Wall	WA-C35-300	SL150-Edge		38.50		1.00	Basic Wall-WA-C35-300-SL150-Edge	m2
81	**Wall Schedule**									--	
82	Level 1		Basic Wall-L	IW-BLK-100				4,550.00	1.00	Basic Wall-L-IW-BLK-100-	m
83	Level 1		Basic Wall-L	EW-C20-125				4,250.00	1.00	Basic Wall-L-EW-C20-125-	m
84	Level 1		Basic Wall-L	EW-C20-125				4,400.00	1.00	Basic Wall-L-EW-C20-125-	m

16. Adding a Floor Parameter for Walls

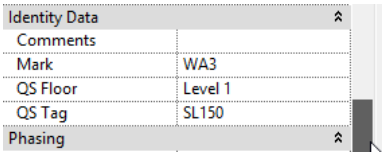
To add a project parameter for Floor (not using shared parameter):

(a) Select Manage > Settings > Project Parameters > Add > Project parameter.

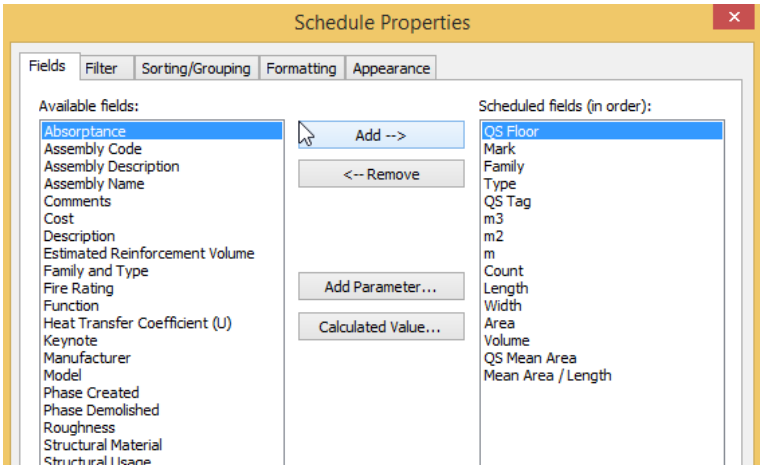
(b) Enter "QS Floor" under Name, select Common, Text, Identity Data, Instance, Walls as follows; and select OK > OK.



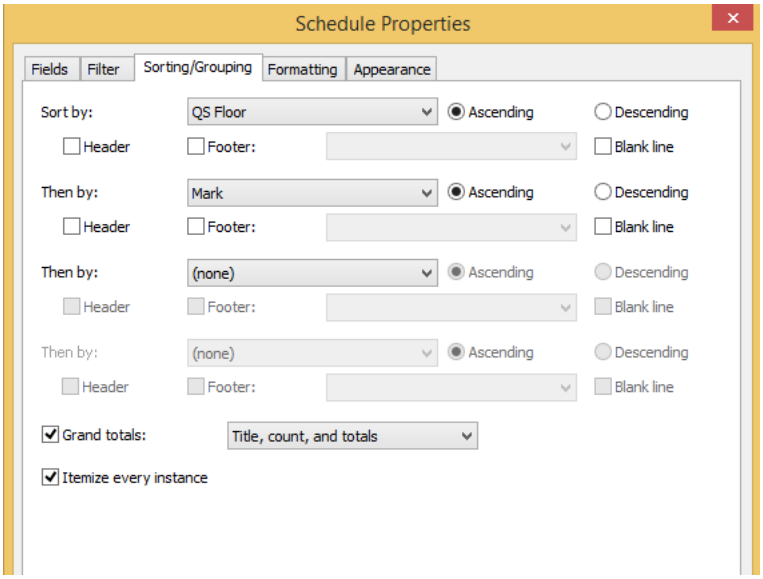
(c) A new parameter will appear in the Properties menu of a selected wall for entering new data.



(d) It will also appear as an Available field in the Schedule Properties - Fields menu of the Wall Schedule. Select Add to move it to the Scheduled fields > Move Up to move it to the top position > OK.



(e) Change the sorting fields under the Sorting/Grouping menu.



(f) The wall schedule will have a column added for QS Floor for entering new data.

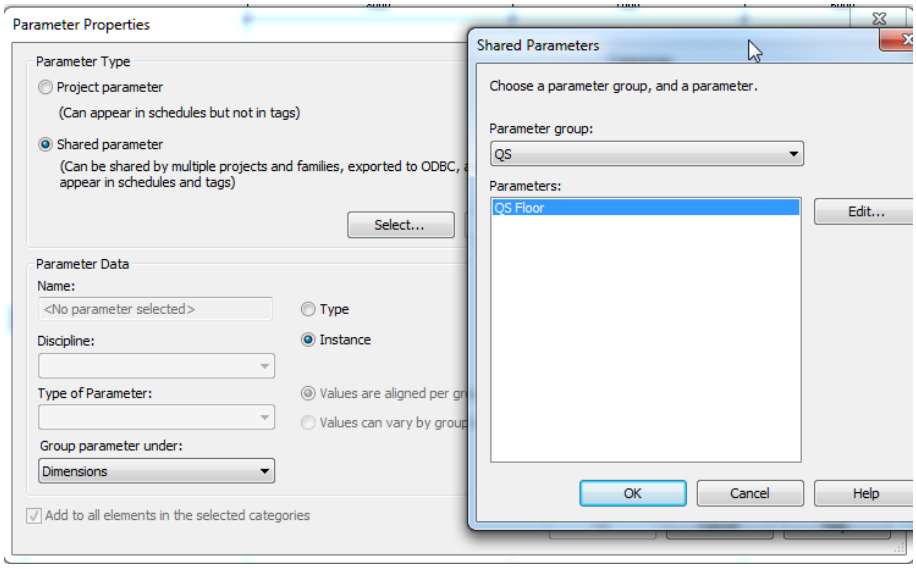
A	B	C	D
QS Floor	Mark	Family	Type
Level 1		Basic Wall	IW-BLK-100
Level 1		Basic Wall	EW-C20-125
Level 1		Basic Wall	EW-C20-125
Level 1		Basic Wall	EW-C20-125
Level 1		Basic Wall	EW-C20-125
Level 1		Basic Wall	EW-C20-125
Level 1		Basic Wall	EW-C20-125
Level 1		Basic Wall	EW-C20-125
Level 1		Basic Wall	EW-C20-125
Level 1		Basic Wall	EW-C20-125
Level 1	WA1	Basic Wall	WA-C35-400
Level 1	WA2	Basic Wall	WA-C35-300
Level 1	WA2A	Basic Wall	WA-C35-300
Level 1	WA3	Basic Wall	WA-C35-300
Level 1	WA4	Basic Wall	WA-C35-300
Level 1	WA5	Basic Wall	WA-C35-300
Level 1	WA6	Basic Wall	WA-C35-300
Level 1	WA7	Basic Wall	WA-C35-300
Level 1	WA8	Basic Wall	WA-C35-300
Grand total: 19			

To add a project parameter for floor using shared parameter:

(a) A shared parameter cannot be added directly to a Wall Family, which is a system family. Therefore, it has to be added indirectly through the project parameter.

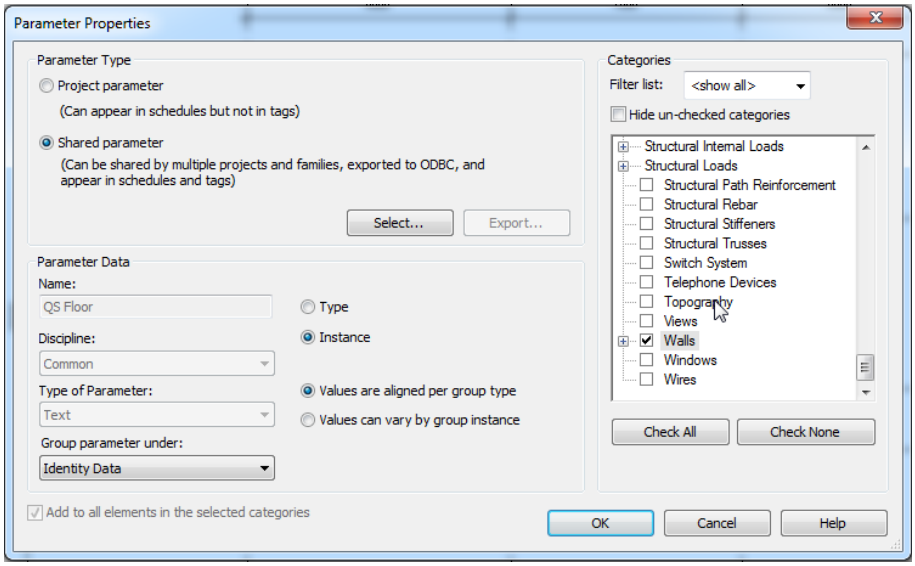
(b) Create a shared parameter called "QS Floor" as described above.

(c) Select Manage > Settings > Project Parameters > Add > Shared parameter > QS Floor under the QS Parameter Group > OK.



(d) Select Identity Data, Instance, Walls as follows; and select OK > OK.

.



(e) A new parameter will appear in the Properties menu of a selected wall for entering new data, and will also appear as an Available field in the Schedule Properties - Fields menu of the Wall Schedule. The rest will be the same at that described above.

17. Representation of Wall Length, Area and Volume

Note the wall length, area and volume have the following representations:

	Wall length given	Area given	Volume given
Straight wall e.g. 12 m long x 4 m high x 300 mm thick	Centre line of wall = 12 m	Elevation area on one face = 12 x 4 m = 48 m2	Area along centre line x wall thickness = 12 x 4 x 0.3 m = 14.4 m3
Wall L-shaped on plan with **mitre** joint e.g. 400 mm wall 8 m long + 300 mm wall 5 m long, both x 4 m high	Centre line of wall with the corner shared between the two wings = 7.85 + 4.80 m = 12.65 m	Elevation area based on the **extreme** length of each wing = 8 x 4 + 5 x 4 m = 32 + 20 m2 = 52 m2	Area along centre line **with the corner shared** x wall thickness = 7.85 x 4 x 0.4 + 4.80 x 4 x 0.3 = 12.56 + 5.76 m3 = 18.32 m3
Wall L-shaped on plan with **butt** joint e.g. 8 m x 400 mm wall + 4.6 m x 300 mm wall, both x 4 m high	Same as above	Elevation area based on the **self** length of each wing = 8 x 4 + 4.6 x 4 m = 32 + 18.4 m2 = 50.4 m2	Area based on **self** length x wall thickness = 8 x 4 x 0.4 + 4.6 x 4 x 0.3 = 32 x 0.4 + 18.4 x 0.3 = 12.80 + 5.52 m3 = 18.32 m3
Wall L-shaped on plan with **butt** joint e.g. 7.7 m x 400 mm wall + 5 m x 300 mm wall, both x 4 m high	Same as above	Elevation area based on the **self** length of each wing = 7.7 x 4 + 5 x 4 m = 30.8 + 20 m2 = 50.8 m2	Area based on **self** length x wall thickness = 7.7 x 4 x 0.4 + 5 x 4 x 0.3 = 30.8 x 0.4 + 20 x 0.3 = 12.32 + 6 m3 = 18.32 m3
Wall T-off from another wall e.g. 4.6 x 300 mm wall T-off from 400 mm wall	Centre line of T-off wall measured to centre line of main wall = 4.6 + 0.2 = 4.8 m	Elevation area based on the **self** length of T-off wall = 4.6 x 4 m = 18.4 m2	Area based on **self** length x wall thickness = 4.6 x 4 x 0.3 = 5.52 m3

The Area and Volume do not make deduction at the junction with floor slab.

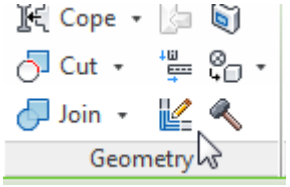
Whether the L-shaped wall is mitre or butt jointed, it does not make any difference to the Volume, but the Areas are different for the three cases.

The area of formwork to sides of wall should be equal to the elevation area along the centre line x height x 2 = (7.85 + 4.8) x 4 x 2 = 50.6 m2 x 2. The Areas given by Revit for the three cases of L-shaped wall are useless for this purpose.

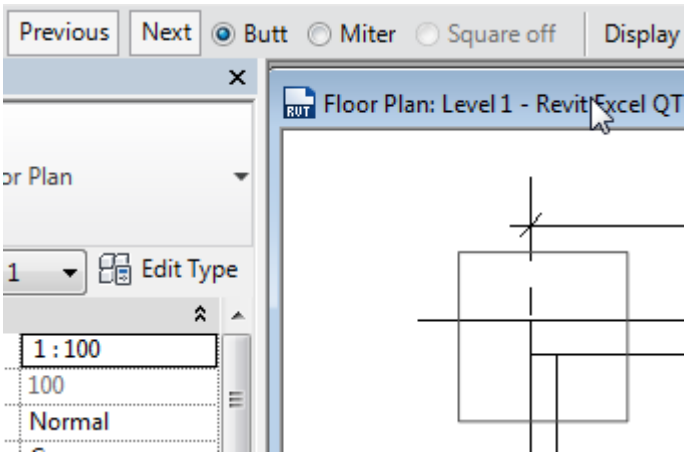
Wall junctions on plan:

(a) It is preferred to use mitre joints at corner junction of walls.

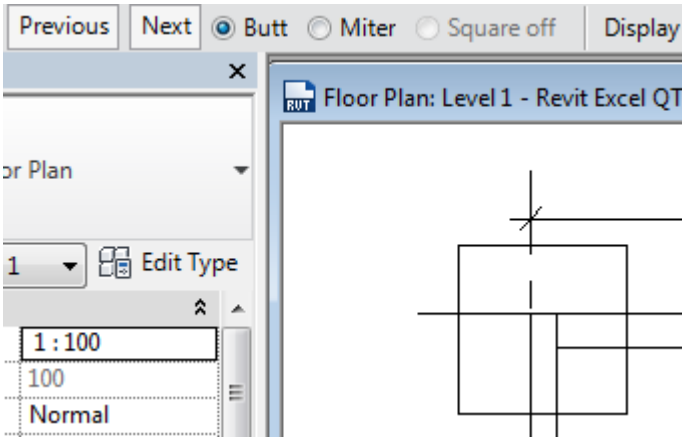
(b) To change the type of wall junctions on plan: select a wall > Wall Joins.



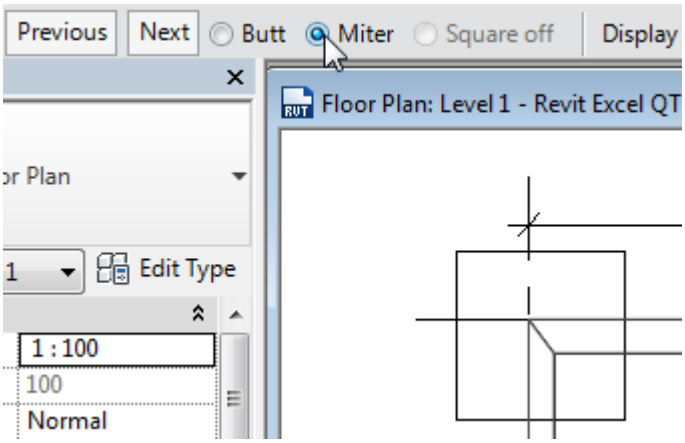
(c) Select Butt to give a butt joint:



(d) Select Previous or Next to change the direction of the joint:



(e) Select Miter for a mitre joint:



After all these discussions, it seems that Volume is a more reliable value to use than Area. Therefore, the area of wall “m2” for Estimate and BQ purposes takes the value of Volume / Width, i.e. the QS Mean Area.

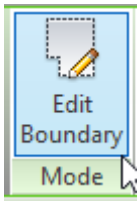
The value of wall “m” is to be used for adjustments for the wall and slab junction, it appears that Length is not accurate enough but close enough and is the only choice available. It is tolerated for the time being.

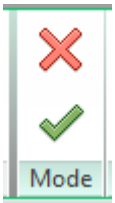
18. Architectural Walls

Architectural walls can be modelled just like a structural wall. However, unlike structural walls which can be taken as going up to the floor level because they usually have stronger concrete grade, architectural walls should go up to beam or ceiling soffit only and not the floor level. Revit does not have a feature to let architectural walls automatically go up and stop there. Therefore, architectural walls have to be modelled one by one to ensure correct height.

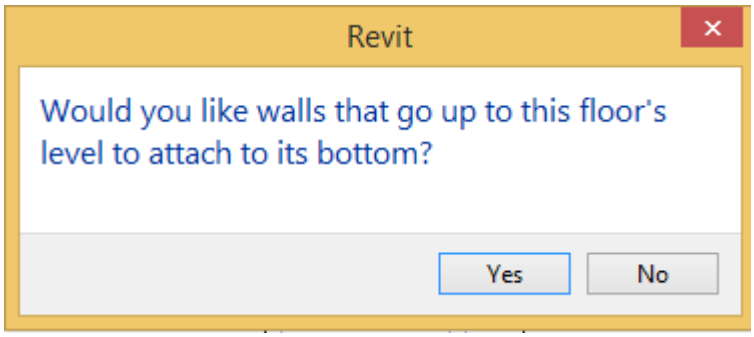
With so many architectural walls within a building, this is a time consuming process and is therefore prone to errors.

19. Floor Slab and Structural Wall Junctions

When modelling, after selecting a floor slab > 

> 

> Yes, the following dialogue will appear and will only appear if there are structural walls underneath the slab:



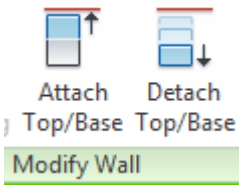
If “Yes” is selected, the volume of the structural walls below will be measured to the underside of the slab, as shown for the wall on the left below.

If “No” is selected, the volume of the structural walls below will be measured to the top of the slab, as shown for the wall on the right below, **but** the reported volume of the slab will not be reduced.

The reported height of the structural walls when defined to be to the top of the slab will not be changed in both cases.

In theory, when a structural wall is attached to the bottom of a floor slab, the wall top will move when the floor slab is moved up or down.

Furthermore, the Modify Wall menu also has the following choices.



However, the behaviour after attaching or detaching walls using the above slab or wall commands is not quite definite every time. Furthermore, since the slab and wall junctions will need to be adjusted in any case, when encountering the above dialogue when editing slab boundary, it is better to answer “No” to retain the default treatment.

20. Structural Column Schedule

The above Structural Column Schedule has the following columns:

Scheduled fields (in order):

- Base Level
- Column Location Mark
- Family
- Type
- QS Tag
- m3
- m2
- m
- Count
- QS App Slab Tk
- Top Level
- Length
- QS Width
- QS Depth
- Volume
- Vol / (Wi x Dp)

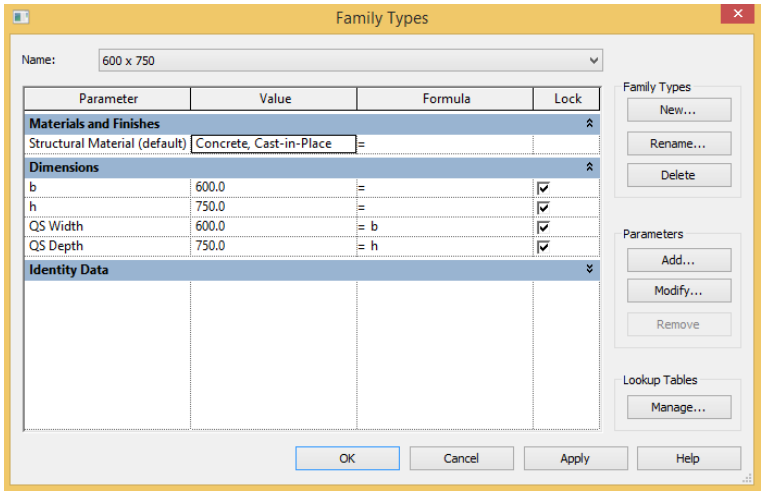
Column Location Mark is a system parameter which gives the grid line references. This is used here instead of the usual Mark.

For a column defined to be of floor to floor height, Volume is a system parameter which gives the volume of concrete below slab, while Length is a system parameter which gives the floor to floor height.

Since the floor to floor height is needed, therefore “m” takes the value of Length.

Like the Wall Schedule, QS Tag is an added shared parameter for giving information like the slab thickness and whether the column is an edge or corner column to facilitate adjustment for slab and column junctions.

It is strange that the column width (b) and depth (h) are not available to the properties window and schedules. Therefore, two shared parameters QS Width and QS Depth have been added to the Family Type parameters to make them available to the schedules to facilitate error checking.



QS App Slab Tk = Length - Volume / (QS Width * QS Depth) which is useful for indicating the approximate slab thickness for counter-checking any errors in positioning the columns.

Vol / (Wi x Dp) = Volume / (QS Width * QS Depth) gives the length of column below slab.

21. Structural Framing Schedule

The above Structural Framing Schedule has the following columns:

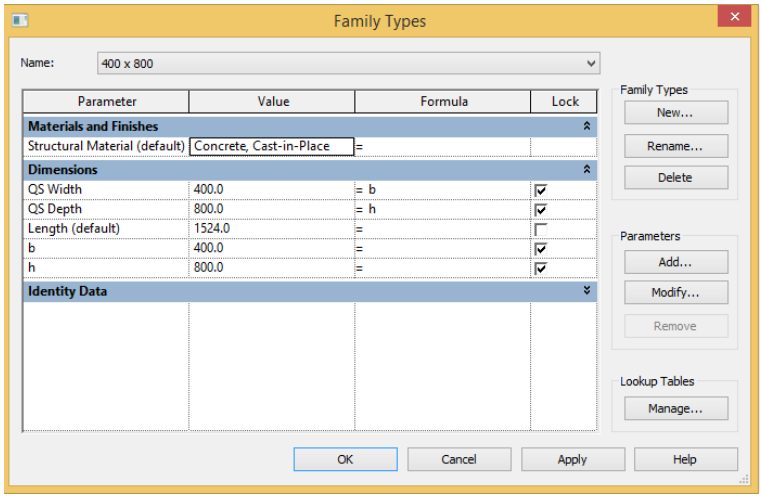
Scheduled fields (in order):

- Reference Level
- Mark
- Family
- Type
- QS Tag
- m3
- m2
- m
- Count
- App SL Tk
- Length
- Cut Length
- QS Width
- QS Depth
- Volume

This Schedule is for beams.

For beams, there are two parameters Length and Cut Length. Only the Cut Length is the length between supporting columns or walls. “m” takes the value of Cut Length.

Similar to structural columns, the beam width (b) and depth (h) are not available to the properties window and schedules. Therefore, two shared parameters QS Width and QS Depth have been added to the Family Type parameters to make them available to the schedules to facilitate error checking.



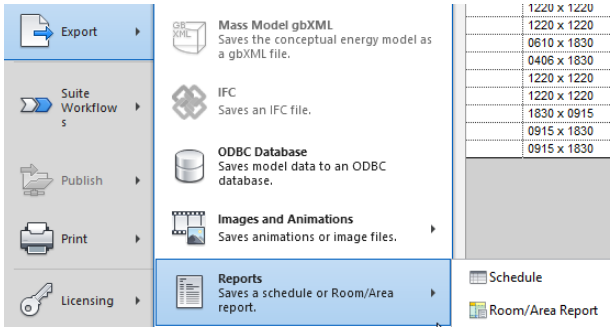
22. Door and Window Schedules

Having reached this point, one should be able to create the above Door Schedule and Window Schedule. Note that QS Tag is for entry of information about the walls housing the doors and windows to facilitate future measurement of formwork to jambs and soffit, boxing and lintels, as shown in the Excel worksheet below:

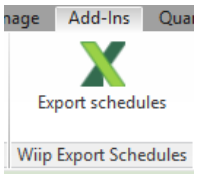
125		**Doors**	0.00							#N/A	0.00
126		D1-1830 x 2134mm-EW-CON-125	1.00						D1-1830 x 2134	Nr	1.00
127		D2-0915 x 2134mm-IW-BLK-100	1.00						D2-0915 x 2134	Nr	1.00
128		D2-0915 x 2134mm-WA-CON-300	1.00						D2-0915 x 2134	Nr	1.00
129		**Jambs and soffit in concrete walls**	0.00							#N/A	0.00
130		D1-1830 x 2134mm-EW-CON-125	1.00	1.83					EW-FWK-J&S-200	Nr	1.83
131		D1-1830 x 2134mm-EW-CON-125	1.00		2.13	2.00			EW-FWK-J&S-200	Nr	4.26
132		D2-0915 x 2134mm-WA-CON-300	1.00	0.92					WA-FWK-J&S-300	Nr	0.92
133		D2-0915 x 2134mm-WA-CON-300	1.00		2.13	2.00			WA-FWK-J&S-300	Nr	4.26
134		**Lintels in brick / block walls**	0.00							#N/A	0.00
135		D2-0915 x 2134mm-IW-BLK-100	1.00	1.22					IW-Lintel-100	Nr	1.22

23. Exporting Schedules to Excel

Revit has a feature to export a Revit schedule to a delimited text file which can be imported into an Excel file.



However, this export can only handle one schedule at a time and this would result in many text files to be imported to Excel. A third party add-in available at Revit's Exchange App website can export all schedules to a single Excel file in one go.



24. Closing

Having set up the Revit schedules and the corresponding Excel worksheets once, they can be re-used as a set of templates for other Revit models. The number of chains of Short Descriptions -> secondary calculations -> Codes can be expanded as and when they are encountered and retained in the templates to serve future use to reduce the burden of re-defining every time.

Get into modelling which is easy and powerful as soon as possible. Understand it, identify the limitations and suggest solutions to make it really productive. Increase our user base and join force to push the software vendors to meet our need.

End