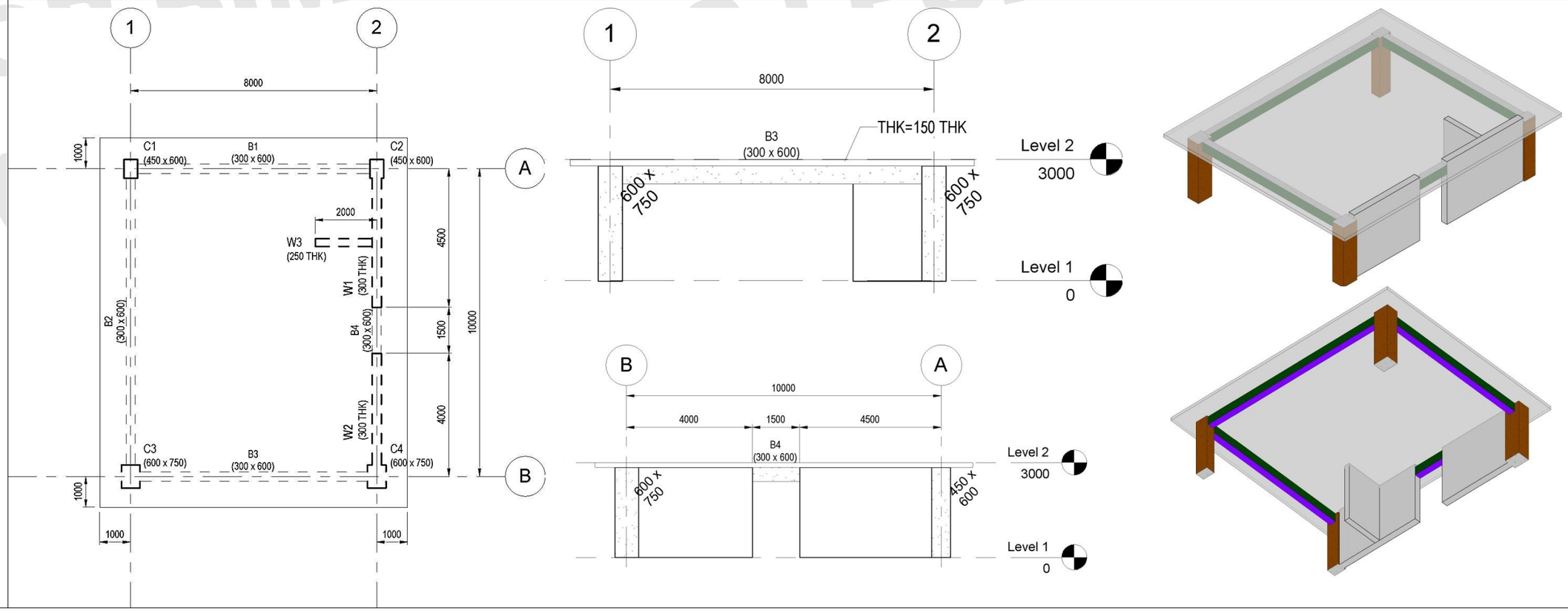
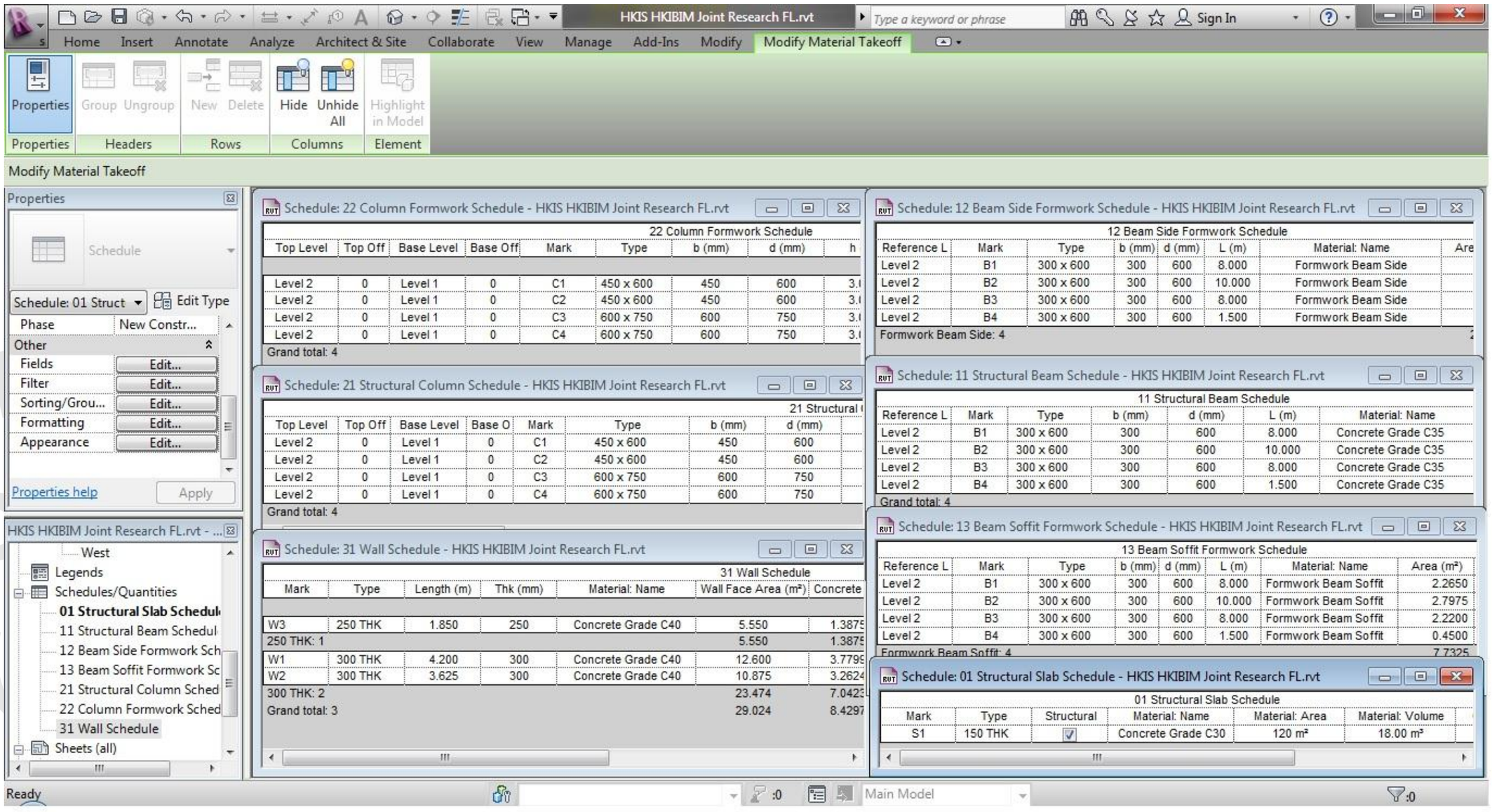
Title:	HKIS HKIBIM Joint Research for BIM Quantity Take-off
Subject:	Structural Elements RC Quantities (Concrete Volume and Formwork Area)
Solution submitted by:	Ir Francis Leung, FHKIE MHKIBIM
BIM Software:	Autodesk Revit
Special Modelling Method:	Modelling method follows simple modelling practice for structural engineering targeting to framing plans production. Summary of the automatic features from Revit and manual adjustment required are: ■ Structural Beams are automatically joined with Structural Slab; ■ Structural Columns are automatically joined with Structural Slab; ■ Structural Walls **DO NOT NEED** to join with Structural Slab; ■ Structural Wall Top Level is lowered by 0.1mm to show hidden lines on plan; ■ Shared Parameters b & h are added to Beam and Column Families; ■ Paint to Beam for formwork is added to Family; ■ Paint to Column for formwork is added to Family; ■ No paint is added to Wall; and ■ Rebar Ratio is MANUALLY input.
Model Images:	

Schedules in Revit Model:



Item:	Structural Slab

Schedule from Revit:

Structural Slab Schedule								
Mark	***Type Name (Manual Input)***	***Material: Name***	***Structural***	***Area***	***Volume***	***Calc Thk***	***Rebar Ratio (kg/m³)***	***Rebar Content (kg)***
S1	*150 THK*	*Concrete Grade C30*	*Yes*	*120 m²*	*18.00 m³*	*150 mm*	*130*	*2,340*

Manual Adjustment:

Deduction for Column-Slab Overlapping: 0.216 m³ *(from Structural Column Schedule)*

Deduction for Wall-Slab Overlapping: 0.4215 m³ *(from Wall Schedule)*

Adjusted Slab Volume = 18.0 – 0.216 – 0.4215 = 17.3625 m³

Hand Calculation Checking:

Width = 10m; Length = 12m; Area = 10 x 12 = 120 m²; Volume = 120 x 0.15 = 18 m³

Remark:

"Calc Thk" is calculated by "Volume / Area" to counter-check the correctness of Type Name.

Sub-item:	Structural Slab Formwork

Formwork Area is calculated by Slab Area minus Column and Wall Cross Sectional Area minus Beam Soffit Formwork Area

Slab Area = 120 m² *(from Structural Slab Schedule)*

Column Cross Sectional Area = 1.440 m² *(from Structural Column Schedule)*

Wall Cross Sectional Area = 2.810 m² *(from Wall Schedule)*

Beam Soffit Formwork Area = 7.733 m² *(from Structural Beam Schedule)*

Adjusted Slab Formwork Area = 120.0 – 1.440 – 2.810 – 7.733 = 108.017 m²

Remark:

Item:	Structural Beam

Structural Beam Schedule from Revit:

Structural Beam Schedule									
Reference Level	Mark	Type	b (mm)	d (mm)	L (m)	Material	Volume (m^3)	Rebar Ratio (kg/m^3)	Rebar Content (b * d * L * Rebar Ratio) (kg)
Level 2	B1	300 x 600	300	600	8.0	Concrete Grade C35	1.019	300	432
Level 2	B2	300 x 600	300	600	10.0	Concrete Grade C35	1.259	300	540
Level 2	B3	300 x 600	300	600	8.0	Concrete Grade C35	0.999	300	432
Level 2	B4	300 x 600	300	600	1.5	Concrete Grade C35	0.203	300	81
Grand total: 4							3.480		1,485

Remark:

b & h are Shared Parameters.

Length is the total length from end-to-end. In this case, it is frome column centre to column centre.

Volume is the net volume with the overlapping between beam-slab and beam-column deducted.

Sub-item:	Structural Beam Formwork

Beam Formwork Schedule from Revit:

Beam Side Formwork Schedule							
Reference Level	Mark	Type	b (mm)	d (mm)	L (m)	Name	Area (m^2)
Level 2	B1	300 x 600	300	600	8.0	Formwork Beam Side	6.7950
Level 2	B2	300 x 600	300	600	10.0	Formwork Beam Side	8.3925
Level 2	B3	300 x 600	300	600	8.0	Formwork Beam Side	6.6600
Level 2	B4	300 x 600	300	600	1.5	Formwork Beam Side	1.3500
Formwork Beam Side: 4							23.1975

Beam Soffit Formwork Schedule								
Reference Level	Mark	Type	b (mm)	d (mm)	L (m)	Name	Area (m^2)	Net Beam Length (Calc) (m)
Level 2	B1	300 x 600	300	600	8.0	Formwork Beam Soffit	2.2650	7.550
Level 2	B2	300 x 600	300	600	10.0	Formwork Beam Soffit	2.7975	9.325
Level 2	B3	300 x 600	300	600	8.0	Formwork Beam Soffit	2.2200	7.400
Level 2	B4	300 x 600	300	600	1.5	Formwork Beam Soffit	0.4500	1.500
Formwork Beam Soffit: 4							7.7325	

Remark:

Material “Formwork Beam Side” and “Formwork Beam Soffit” are added to Beam Family.

Formwork Beam Side is calculated for area under Slab.

Item:	Structural Column

Structural Column Schedule from Revit:

Structural Column Schedule

Top Level	Top Offset (m)	Base Level	Base Offset (m)	Mark	Type	b (mm)	d (mm)	h (m)	Material	Cross Sectional Area (m²)	Volume (m³)	SMM Volume (m³) b*h*Length	Volume Adjustment (m³)	Calc Slab Thk (mm)	Rebar Ratio (kg/m³)	Rebar Content (b * d * h* Rebar Ratio) (kg)
Level 2	0	Level 1	0	C1	450 x 600	450	600	3.00	Concrete Grade C40	0.270	0.7695	0.8100	0.0405	150	300	243
Level 2	0	Level 1	0	C2	450 x 600	450	600	3.00	Concrete Grade C40	0.270	0.7695	0.8100	0.0405	150	300	243
Level 2	0	Level 1	0	C3	600 x 750	600	750	3.00	Concrete Grade C40	0.450	1.2825	1.3500	0.0675	150	300	405
Level 2	0	Level 1	0	C4	600 x 750	600	750	3.00	Concrete Grade C40	0.450	1.2825	1.3500	0.0675	150	300	405
Grand total: 4										**1.440**	**4.1040**	**4.3200**	**0.2160**			**1,296**

Remark:

Volume is directly obtained from Model. Overlapping between Column and Slab is counted as Slab therefore less than SMM Volume.

Calc Slab Thk is calculated by Volume Adjustment divided by Cross Sectional Area to counter-check the thickness of overlapping between Column and Slab.

Sub-item:	Structural Column Formwork

Column Formwork Schedule from Revit:

Column Formwork Schedule

Top Level	Top Offset (m)	Base Level	Base Offset (m)	Mark	Type	b (mm)	d (mm)	h (m)	Name	Area (m²)	Height (Calc) (m)
Level 2	0	Level 1	0	C1	450 x 600	450	600	3.00	Formwork Column	5.985	2.850
Level 2	0	Level 1	0	C2	450 x 600	450	600	3.00	Formwork Column	5.985	2.850
Level 2	0	Level 1	0	C3	600 x 750	600	750	3.00	Formwork Column	7.695	2.850
Level 2	0	Level 1	0	C4	600 x 750	600	750	3.00	Formwork Column	7.695	2.850
Grand total: 4										**27.360**	

Hand Calculation Checking:

Formwork Area for C1 = (0.30 +0.70) x 2 x (3.0 – 0.15) = 5.70 m²

Remark:

Formwork area is calculated without deduction for Column-Beam interface.

Formwork area is calculated to the area under slab.

Material “Formwork Column” is added to Family.

Item:	Structural Wall

Wall Schedule from Revit:

Wall Schedule

Mark	Type	Length (m)	Width (mm)	Material: Name	Wall Face Area (m²)	Conc. Volume (m³)	Cross Sectional Area (m²)	Slab Thk (mm)	Volume Overlapped (m³)	Wall Height (Calc) (m)	Adjusted Wall Face Area (m²)	Rebar Ratio (kg/m³)	Rebar Content (Conc Volume* Rebar Ratio) (kg)
W3	250 THK	2.000	250	Concrete Grade C40	5.550	1.3875	0.4630	150	0.0694	3.000	5.27231	150	208
250 THK: 1					5.550	1.3875	0.4630		0.0694		5.27231		208
W1	300 THK	4.200	300	Concrete Grade C40	12.600	3.7799	1.2600	150	0.1890	3.000	11.96958	150	567
W2	300 THK	3.625	300	Concrete Grade C40	10.875	3.2624	1.0880	150	0.1631	3.000	10.33089	150	489
300 THK: 2					23.474	7.0423	2.3480		0.3521		22.30047		1,056
Grand total: 3					**29.024**	**8.4297**	**2.8100**		**0.4215**		**27.57278**		**1,264**

Hand Calculation Checking:

Wall Area for W1 = 4.20 x (3.0 – 0.15) = 11.97 m²

Wall Volume for W1 = 11.97 x 0.3 = 3.5910 m³

Remark:

"Slab Thk" is a MANUALLY input parameter to calculate Volume Adjustment.

"Wall Height (Calc)" is calculated from "Wall Face Area" divided by "Length"

"Wall Height + Slab Thk" is the sum of "Slab Thk" and "Wall Height (Calc)"

Sub-item:	Wall Formwork

Wall Formwork Area = Wall Area in Wall Schedule = 27.57278 m²

Item:	Rebar Content

Results from Schedules:

Results from Schedules:

Type of Structure	Rebar Content (kg)
Slab	2,340
Beam	1,485
Column	1,296
Wall	1,264
Total:	**6,385**

Rebar Content per Floor Area = 6,385 / 120 = 53.21 kg/m²