

Managing Concrete & Rebar Wastage with Constructible Modelling and Digital Construction

Trimble Snapshot



Company



NASDAQ:
TRMB



\$3.10B
In Revenue



31%+
Building & Infrastructure



Innovation



2,000
Patents



360 Construction Workflow
& Technology Patents



14%
R&D re-invested



People



9000+ Employees
in 35 Countries



800+ Construction
Professionals



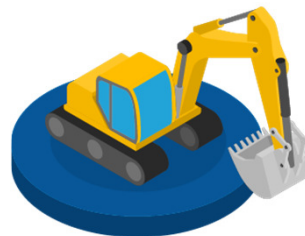
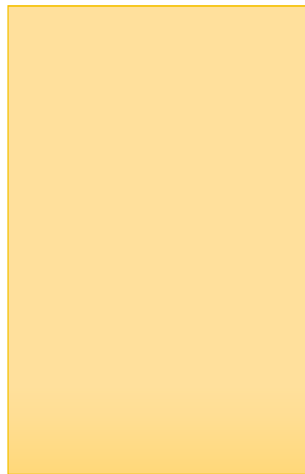
Global Customers
in **150** countries

Core Business Franchises

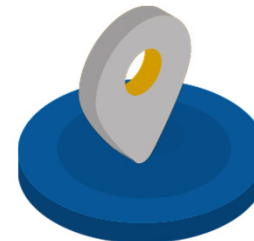
Our core industries are global trillion \$ industries which operate in demanding environments, with technology adoption in the early phases



Agriculture



Civil Engineering
and Construction

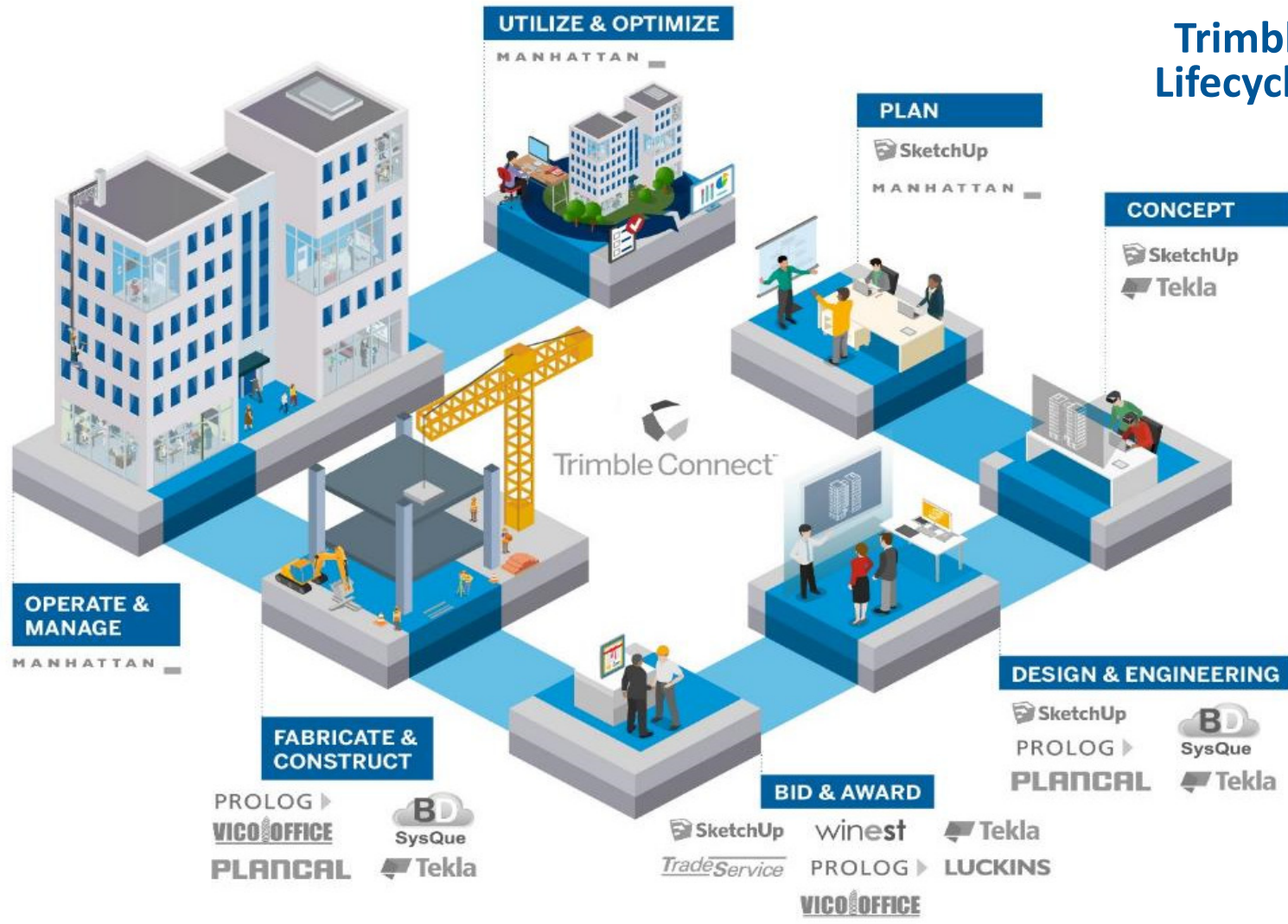


Geospatial



Transportation
and Logistics

Trimble Building Lifecycle Solutions



Trimble Buildings

Structures



Solutions for advanced building information modeling and structural engineering.




Tekla
Structures




Tekla **Tekla**
Tedds Structural Designer

Architecture




Conceptualization, visualization and communication software for architects and planners.

MEP Contractors



Trimble's suite of hardware and software solutions for MEP contractors, from the office to the field.

General Contractors



Building-intelligence software, hardware, and services for general contractors and construction managers.

Real Estate & Workplace Solutions



Capital project and facility management solutions spanning a building's entire lifecycle.



Industry Challenges



10%
of materials
are wasted



40%
of projects are
over budget



30%
of construction
is rework



90%
of projects
are late



40%
of occupied buildings
are utilized



40%
of jobsite work
is unproductive

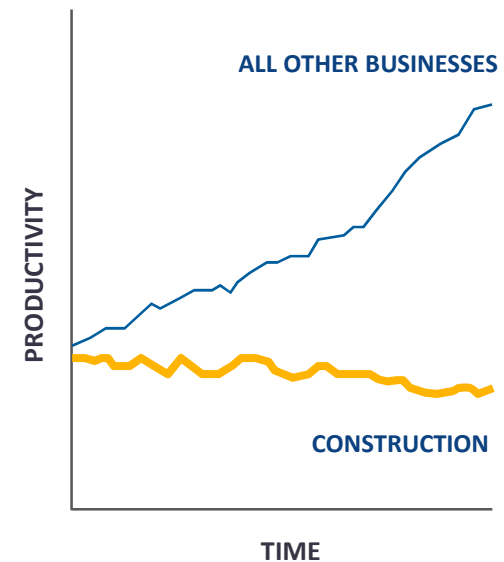


Table 6: Percentage wastage of materials for various trades for private and public housing projects (Source: Poon et al., 2001a)

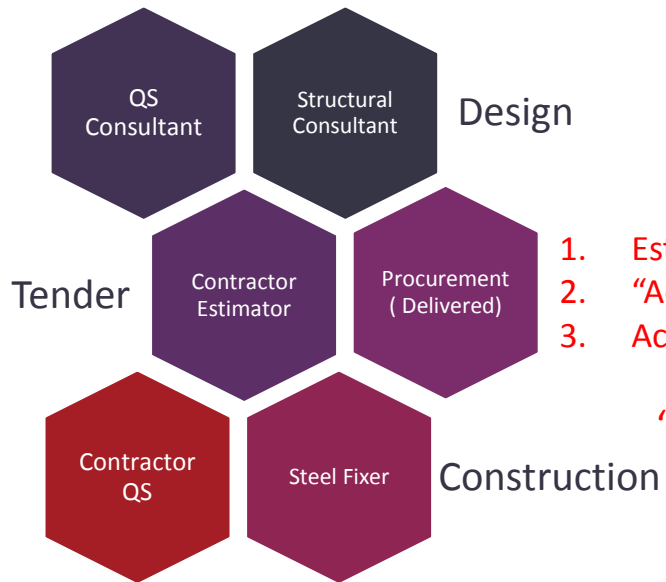
Trade	Material	Percentage wastage in private housing %	Percentage wastage in public housing %
Concrete	Concrete	4-5	3-5
Reinforcement	Steel bars	1-8	1-8
Formwork	Timber broad	15	5
Masonry	Brick and block	4-8	6

Table 4: Maximum and minimum wastes among different types of projects

Project	Concrete			Reinforcement			Formwork			Brick/Block		
	Min. %	Max. %	Max-Min %	Min. %	Max. %	Max-Min %	Min. %	Max. %	Max-Min %	Min. %	Max. %	Max-Min %
Public housing	3.49	13.56	10.08	2.96	5.45	2.48	-	-	-	-	-	-
Private housing	1.13	9.00	7.88	1.81	10.96	9.15	1.79	20.00	18.21	1.66	6.67	5.01
Private Commercial	4.35	4.98	0.64	3.09	5.00	1.91	5.00	5.13	0.13	5.02	5.02	0.00
Composite Bldg	6.67	6.94	0.28	5.00	5.11	0.11	-	-	-	6.92	6.92	0.00
Industrial	2.00	2.00	0.00	3.00	3.00	0.00	-	-	-	3.00	3.00	0.00
Monastery	5.00	5.00	0.00	4.29	5.00	0.71	10.00	15.00	5.00	-	-	-
School	8.70	8.70	0.00	-	-	-	-	-	-	3.33	3.33	0.00

Material Wastage in Construction Activities – A Hong Kong Survey

Definition of Wastage



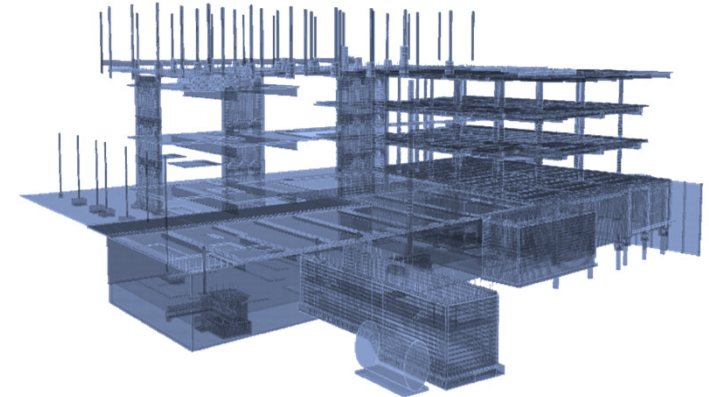
1. Estimated Qty during Tender
2. "Actual" qty as per As-built-drawing
3. Actual quantity Purchased

"Which is the baseline"

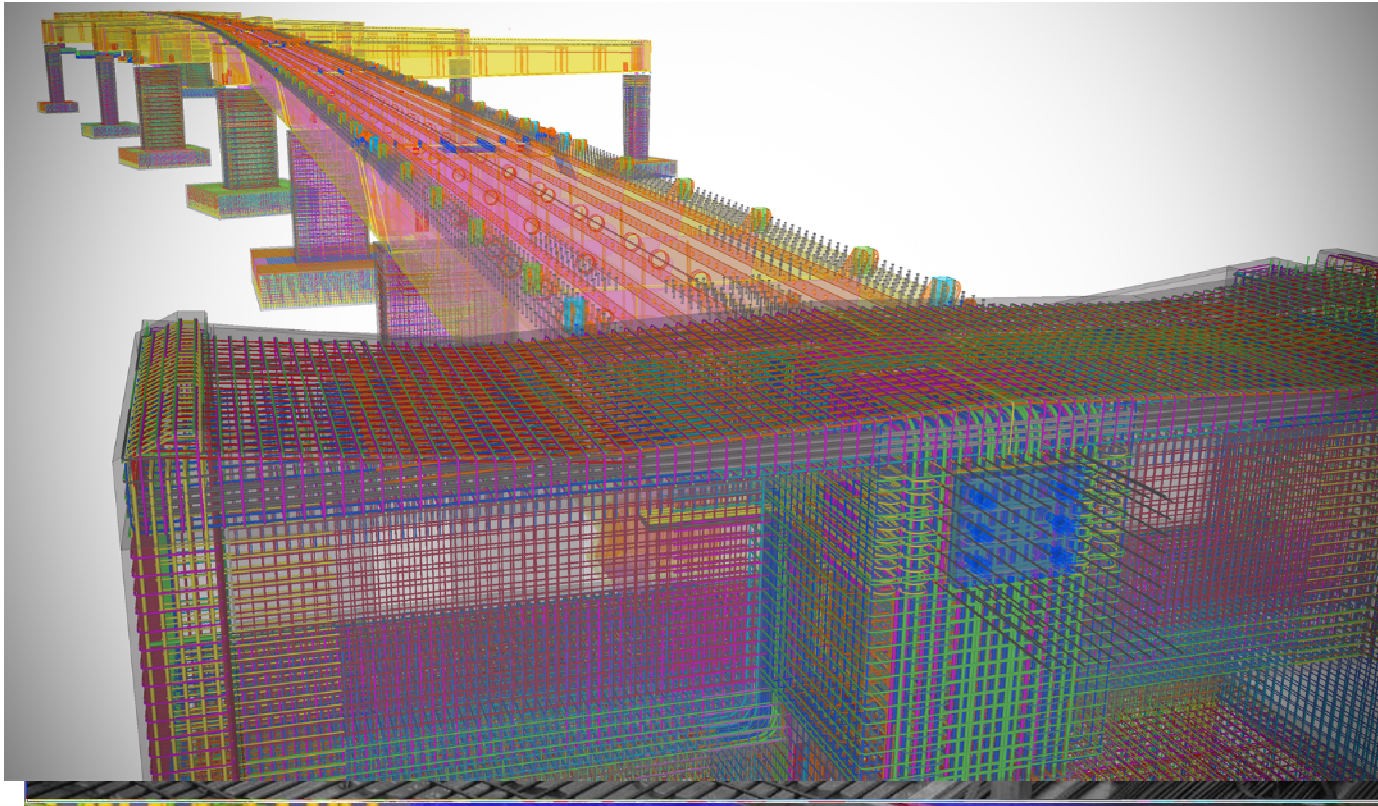
Differences & Discrepancies in Quantity

The Challenge

The greatest challenge facing the global concrete construction industry is the **lack of quality, coordinated and timely information.**

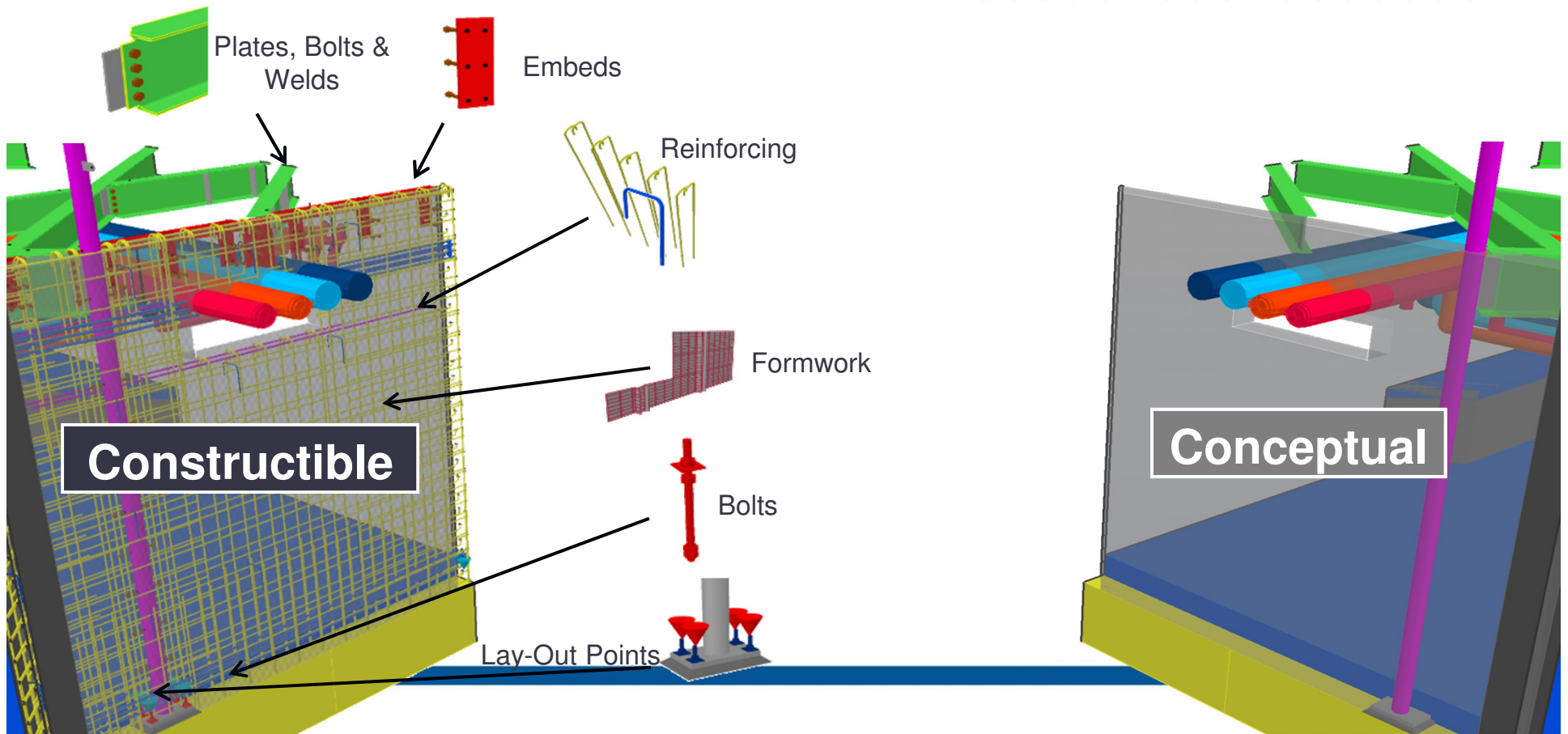


What if you can have accurate quantities ?





Constructible BIM Model (Details + Constructibility)





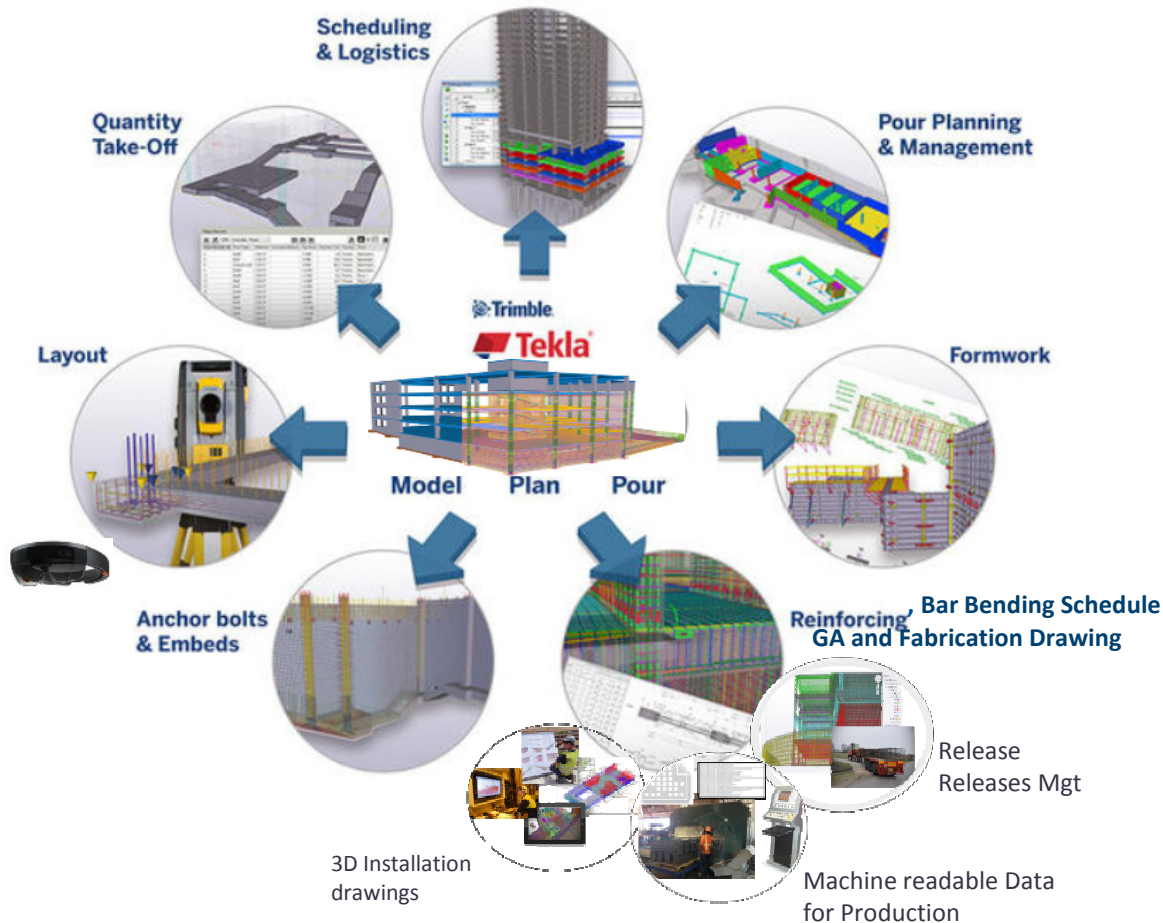
Accurate quantities & data from Constructible BIM Model

1st Floor columns and walls

Name	Count	Material	Profile	Length / mm	Volume / m3	Top level / mm	Section	Floor
WALL	1	C30/37	3200*160	5 550	2,0	3 400	Frame	Floor 1
WALL	2	C30/37	3200*160	4 670	2,4	3 400	Frame	Floor 1
WALL	1	C30/37	3200*160	5 550	2,8	3 400	Frame	Floor 1
WALL	1	C30/37	3200*160	6 800	3,5	3 400	Frame	Floor 1
WALL	1	C30/37	3200*160	10 400	5,3	3 400	Frame	Floor 1
COLUMN	3	C30/37	400*400	3 200	0,5	3 400	Frame	Floor 1
COLUMN	21	C30/37	400*400	2 800	0,4	3 000	Frame	Floor 1

Number of objects in the table: 30 Result of: Total Of these rows: All

BIM Constructible BIM – One common source



Estimator



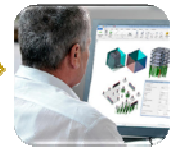
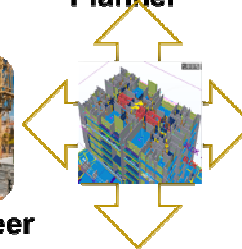
Planner



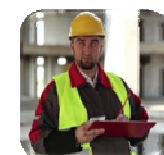
Purchaser



Site Engineer



Designer



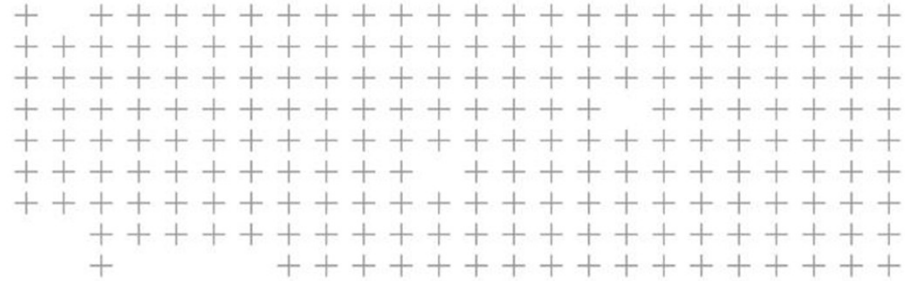
Supervisor



Project Mgr

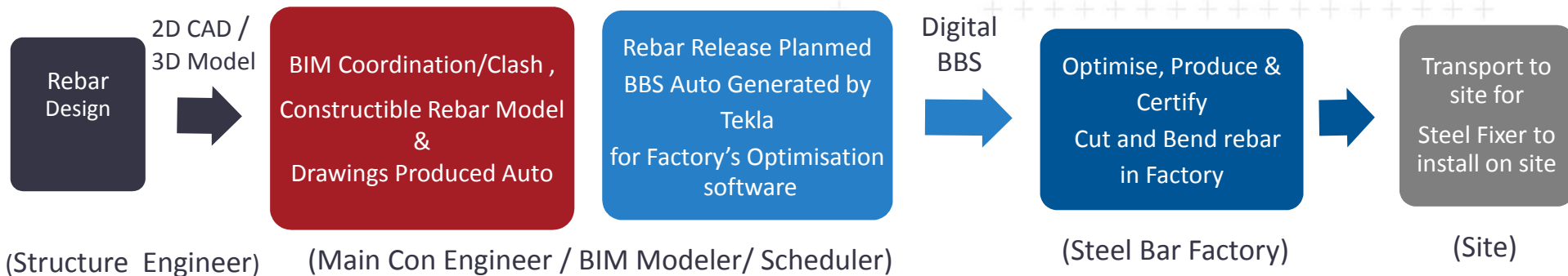


Surveyor



Hong Kong BIM Workflow

BIM enables Digital Fabrication to speed up Rebar Construction

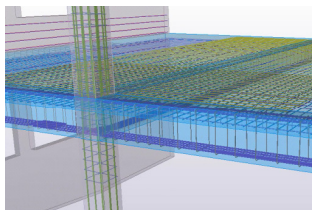
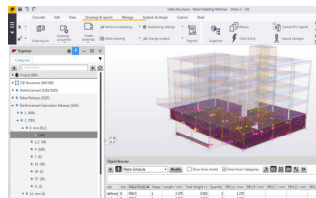
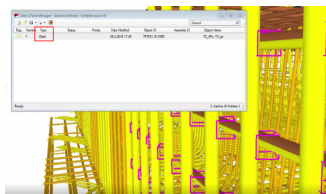
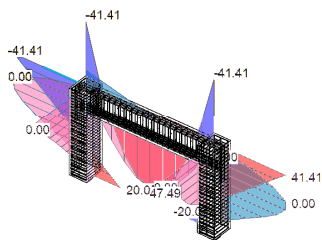


(Structure Engineer)

(Main Con Engineer / BIM Modeler/ Scheduler)

(Steel Bar Factory)

(Site)



Family	Type	Shape	Rebar	Bar Length	A	B	C	D	E
Rebar Bar	120	00	120mm	2000mm	2000mm	0mm	0mm	0mm	0mm
Rebar Bar	120	00	120mm	2000mm	2000mm	0mm	0mm	0mm	0mm
Rebar Bar	120	01	120mm	2000mm	1000mm	1000mm	0mm	0mm	0mm
Rebar Bar	120	00	120mm	2000mm	2000mm	0mm	0mm	0mm	0mm
Rebar Bar	120	00	120mm	2000mm	2000mm	0mm	0mm	0mm	0mm
Rebar Bar	120	01	120mm	2000mm	1000mm	1000mm	0mm	0mm	0mm
Rebar Bar	120	01	120mm	2000mm	1000mm	1000mm	0mm	0mm	0mm
Rebar Bar	120	01	120mm	2000mm	1000mm	1000mm	0mm	0mm	0mm
Rebar Bar	120	01	120mm	2000mm	1000mm	1000mm	0mm	0mm	0mm
Rebar Bar	120	01	120mm	2000mm	1000mm	1000mm	0mm	0mm	0mm
Rebar Bar	120	01	120mm	2000mm	1000mm	1000mm	0mm	0mm	0mm
Rebar Bar	120	01	120mm	2000mm	1000mm	1000mm	0mm	0mm	0mm



QR Code and Tags for each Rebars



BIM Constructible Model, Export of Rebar Data and Rebar Status

The screenshot displays the 'Category Properties' dialog box for the category 'Reinforcement Fabrication Releases' (ID: 5165). The dialog is configured with the following settings:

- Name:** Reinforcement Fabrication Releases (5165)
- Rules for setting category content:**
 - Automated object content:**
 - Automated subcategories:**
 - Grouping in Object Browser
 - Object properties used to create automated subcategories under "Reinforcement Fabrication Releases":
 - Create subcategories based on: UDA - PACKAGE_NUMBER
 - Create subcategories based on: DIAMETER_NOMINAL
 - Create subcategories based on: SHAPE
 - Create subcategories based on: (empty)
- Update category at synchronization
- Property template: Rebar Schedule

At the bottom of the dialog, there is a 'Delete Category' button and 'Modify' and 'Close' buttons.

In the background, the software interface shows a 3D model of a rebar structure. A data table is visible at the bottom right of the interface, showing the following data:

ht / t	Quantity	DIM_A / mm	DIM_B / mm	DIM_C / mm	DIM_D / mm	DIM_E / mm	DIM_F / mm
0,007	2	5 484					
0,001	2	306	306				
0,005	2	4 245					
0,003	2	2 632					
0,005	2	3 832					
0,005	2	6 549					
n n n s	2	6 549					
3,896		L 225,000					

The table also includes a 'Result of: Total' dropdown and 'Of these rows: All' dropdown. The status bar at the bottom indicates '0 Pan Current phase: 1' and '5165 + 0 object(s) selected'.

Compare Cutting with different length of materials (Optimisation)

GOLIK

Run reference 07/08/2018 #4	Cutting Optimization list MB#1	07/08/18 10:06 Page 1/1 List N° 1 1 B 20
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331118080704002001

取料長度	用料支數	噸	Nb. bars	112	Nb. cuttgs	26
12000	34	1.01	Nb. tags	6	Cycles nb.	8

8.62%

尾料百分比	8.62%	Bars / Cycle	4.25	尾料重量	80Kg
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1	Y20		用料長 (Mm)	12000	8 次	(1 x 8 Bar(s))	尾料長	382
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2739	1	JOB18 - 15 / SEQ-1734	1H-1	10			
2	1100	1	JOB18 - 15 / SEQ-1734	1TI-1	8			
3	7779	1	JOB18 - 15 / SEQ-1734	1B2T2	14			

2	Y20		用料長 (Mm)	12000	2 次	(1 x 2 Bar(s))	尾料長	1482
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2739	1	JOB18 - 15 / SEQ-1734	1H-1	2			
2	7779	1	JOB18 - 15 / SEQ-1734	1B2T2	6			

3	Y20		用料長 (Mm)	12000	4 次	(1 x 4 Bar(s))	尾料長	1842
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2379	1	JOB18 - 15 / SEQ-1734	1B1T1	35			
2	7779	1	JOB18 - 15 / SEQ-1734	1B2T2	4			

4	Y20		用料長 (Mm)	12000	10 次	(1 x 10 Bar(s))	尾料長	842
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2379	2	JOB18 - 15 / SEQ-1734	1B1T1	31			
2	6400	1	JOB18 - 15 / SEQ-1734	1H-2	10			

5	Y20		用料長 (Mm)	12000	2 次	(1 x 2 Bar(s))	尾料長	105
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2379	5	JOB18 - 15 / SEQ-1734	1B1T1	11			

6	Y20		用料長 (Mm)	12000	1 次	(1 x 1 Bar(s))	尾料長	105
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2379	4	JOB18 - 15 / SEQ-1734	1B1T1	35			
2	2379	1	JOB18 - 15 / SEQ-1734	1B1T1	1			

GOLIK

Run reference 07/08/2018 #4	Cutting Optimization list MB#1	07/08/18 10:04 Page 1/2 List N° 1 1 B 20
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331118080704002001

取料長度	用料支數	噸	Nb. bars	112	Nb. cuttgs	33
9000	13	0.29	Nb. tags	6	Cycles nb.	9
12000	9	0.27				
13500	12	0.40				

3.03%

尾料百分比	3.03%	Bars / Cycle	3.78	尾料重量	28Kg
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1	Y20		用料長 (Mm)	13500	2 次	(1 x 2 Bar(s))	尾料長	42
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2379	1	JOB18 - 15 / SEQ-1734	1B1T1	35			
2	1100	3	JOB18 - 15 / SEQ-1734	1TI-1	8			
3	7779	1	JOB18 - 15 / SEQ-1734	1B2T2	14			

2	Y20		用料長 (Mm)	9000	2 次	(1 x 2 Bar(s))	尾料長	121
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	1100	1	JOB18 - 15 / SEQ-1734	1TI-1	2			
2	7779	1	JOB18 - 15 / SEQ-1734	1B2T2	12			

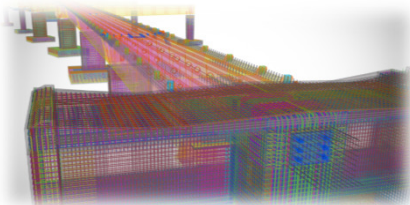
3	Y20		用料長 (Mm)	13500	5 次	(1 x 5 Bar(s))	尾料長	243
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2739	2	JOB18 - 15 / SEQ-1734	1H-1	10			
2	7779	1	JOB18 - 15 / SEQ-1734	1B2T2	10			

4	Y20		用料長 (Mm)	13500	5 次	(1 x 5 Bar(s))	尾料長	963
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2379	2	JOB18 - 15 / SEQ-1734	1B1T1	33			
2	7779	1	JOB18 - 15 / SEQ-1734	1B2T2	5			

5	Y20		用料長 (Mm)	9000	10 次	(1 x 10 Bar(s))	尾料長	221
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2379	1	JOB18 - 15 / SEQ-1734	1B1T1	23			
2	6400	1	JOB18 - 15 / SEQ-1734	1H-2	10			

6	Y20		用料長 (Mm)	12000	2 次	(1 x 2 Bar(s))	尾料長	105
N°	剪料長 (Mm)	刀	工作單	Barmark	需要支數			
1	2379	5	JOB18 - 15 / SEQ-1734	1B1T1	13			

Working with Contractors to produce rebar model & BBS for Rebar Factory



Constructible
BIM

Main Con

Bar Bending schedule
Fixing drawing with marking (3D)

• Accurate bar quantity
• Traceability report
• Stock movement report

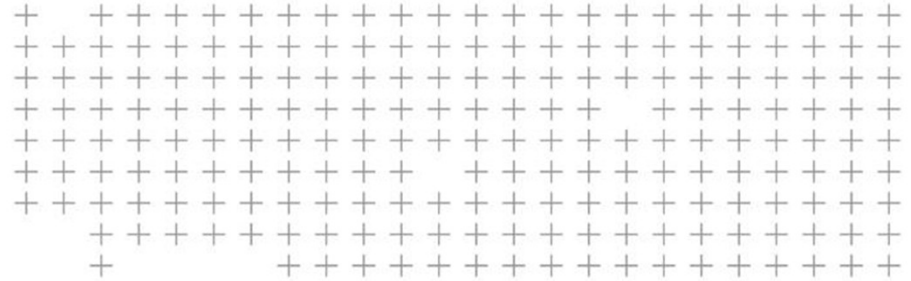
Sub Con
On-site Steel fixer

- Confirmed BBS
- Delivery Schedule

Sub Con
Off-site Cut & Bend

1-2 days
production

- Fabricated bars with marking tags



References

Optimising Rebar with Constructible BIM

- Makati Corp, Philippines



MDC is a premier Filipino EPCCM company. As Ayala Land Inc.'s subsidiary and construction arm, MDC plays a role as it serves 100% of ALI's construction projects.



MDC is a full scale, turnkey company providing Engineering, Procurement, Construction Management services.



Using TEKLA

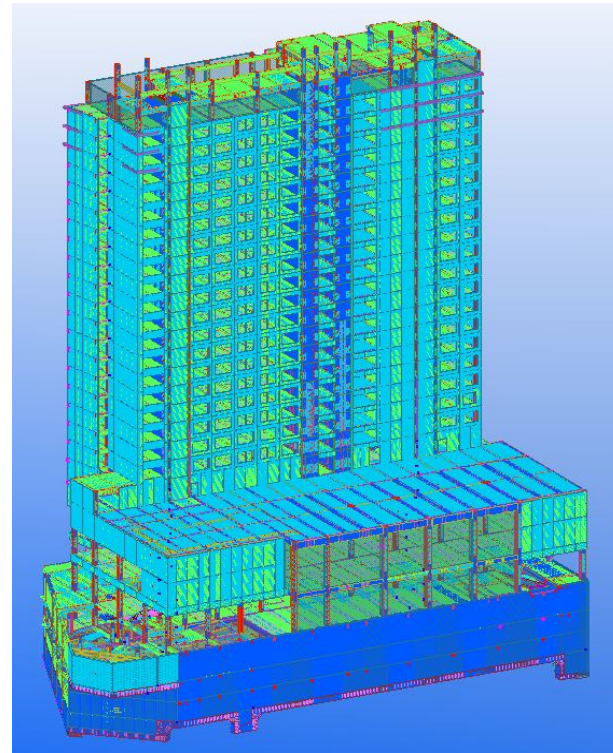
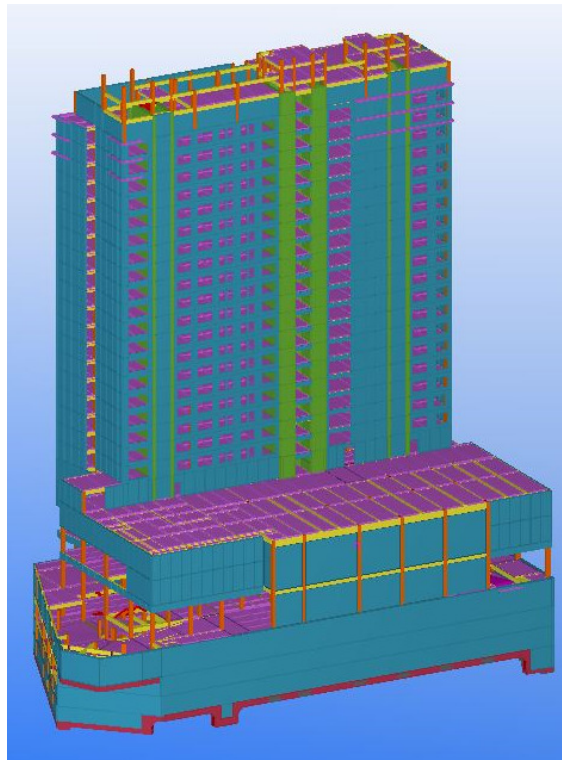


❖ Where and What did you utilize Tekla

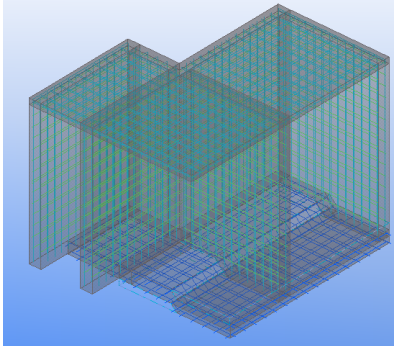
1. Model structures for quantification during pre-construction stage.
2. Connect and model during design changes.
3. Utilize it for Rebar fabrication as cutting list.



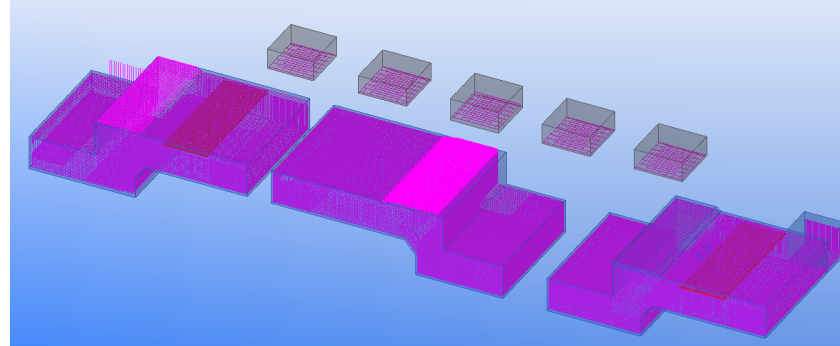
TEKLA Projects



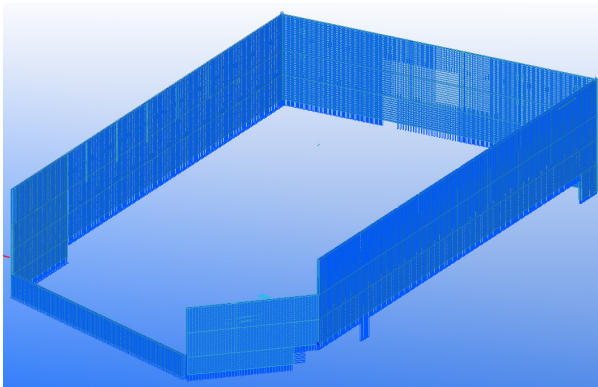
TEKLA Projects



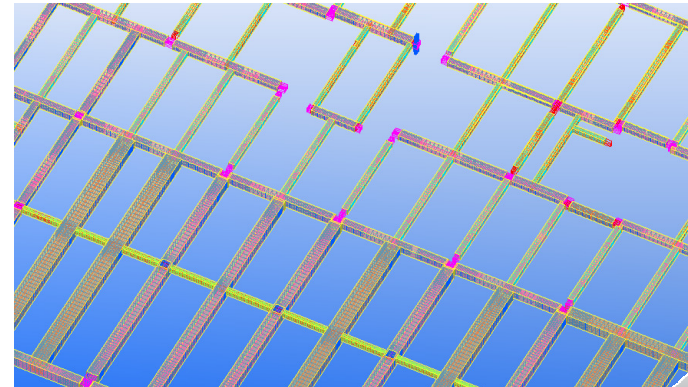
SUMP PIT



FOUNDATIONS



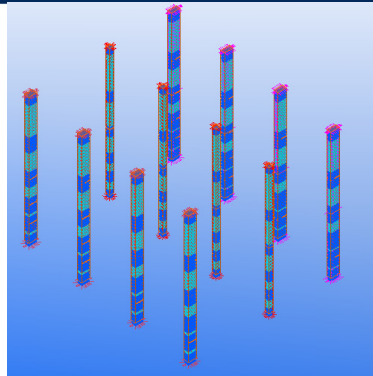
RETAINING WALLS



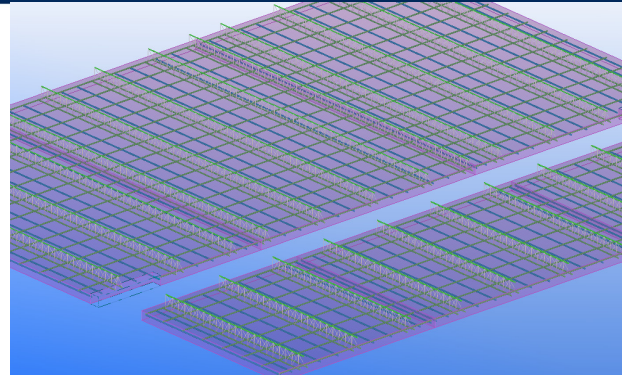
BEAMS AND GIRDERS



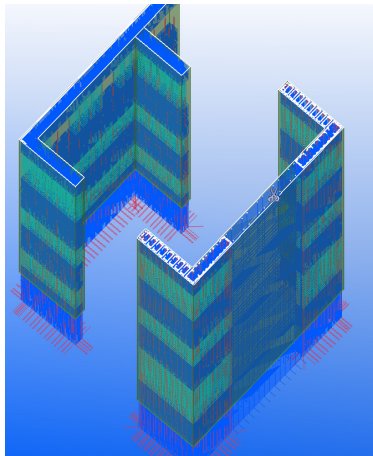
TEKLA Projects



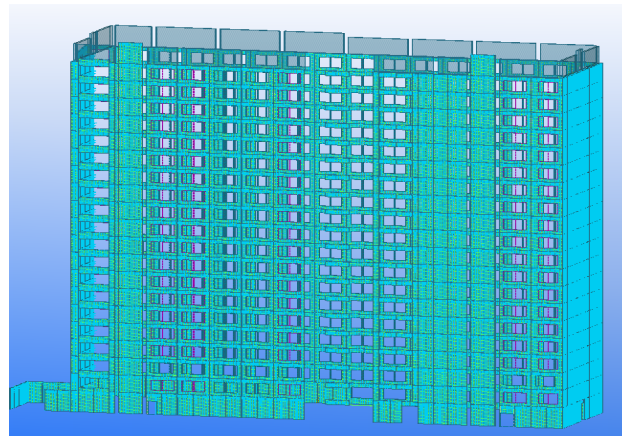
COLUMNS



TRAN SLABS



SHEARWALLS

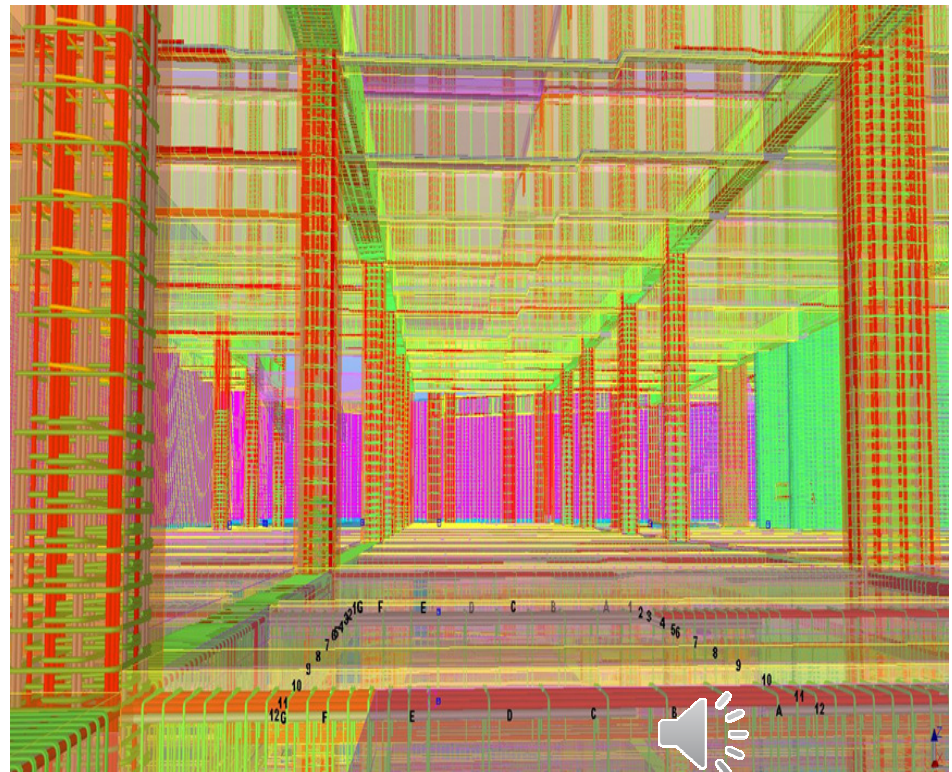


PRECAST WALLS



STATUS REPORT

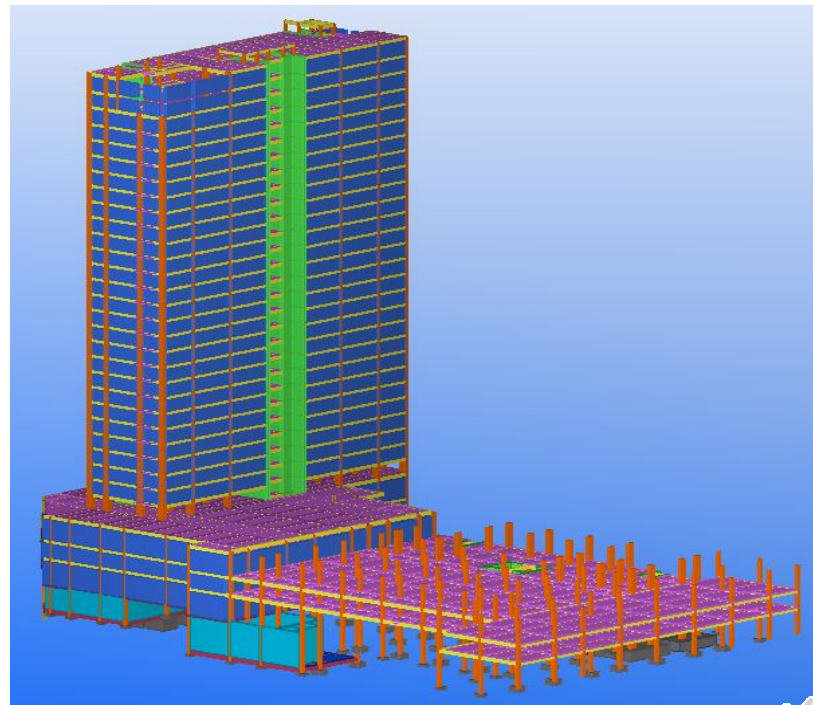
DESCRIPTION	UNIT	RECONCILED	TSD TEKLA
		QTY	FINAL
CONCRETE REINFORCEMENT			
Ø3210 Reinforcing Steel			
Fabrication and Installation Only			
Reinforcing Steel Bars - Grade 60			
to Foundation	kg	158,365.60	171,255.13
to Column	kg	734,306.23	755,241.81
to Shearwall	kg	923,714.88	915,571.25
to Beams and Girders	kg	1,160,504.45	1,067,210.60
to Link Beams	kg		15,889.18
to Suspended Slabs	kg	259,698.84	116,435.15
to Trans-Slab	kg		26,583.62
to Retaining Walls	kg	121,792.02	75,334.83
to RC Walls	kg	31,925.66	16,166.09
to Stairs	kg	42,165.78	45,048.28
to Water Tank	kg		8,952.93
to Slab on Grade	kg	11,071.31	10,643.48
to Sump Pit	kg	2,830.56	2,163.81
Reinforcing Steel Bars - Grade 40			
to Foundation	kg		
to Beams and Girders	kg	35,842.13	33,320.89
to Suspended Slabs	kg	206,248.19	116,419.27
to Trans-Slab	kg		95,373.65
to Slab on Grade	kg	7,680.45	5,818.64
to RC Walls	kg	20,574.34	8,919.19
to Water Tank	kg		4,940.94
to Sump pit	kg	448.94	494.92
		3,717,169.38	3,491,288.74



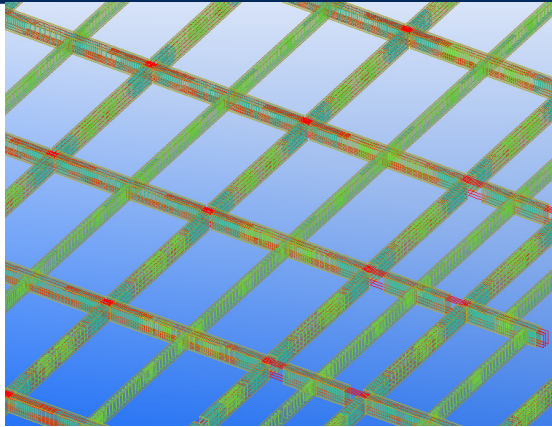
TEKLA Projects



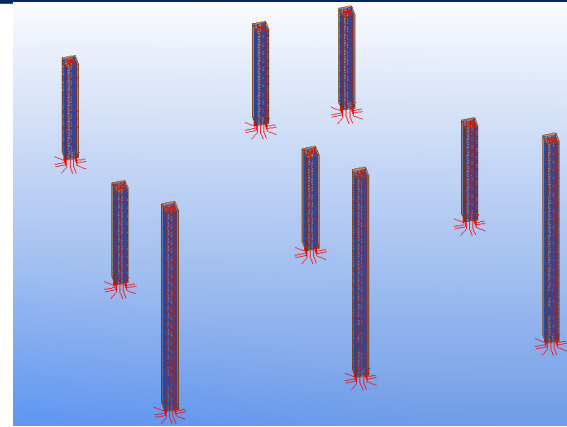
From Podium1 to Tower1



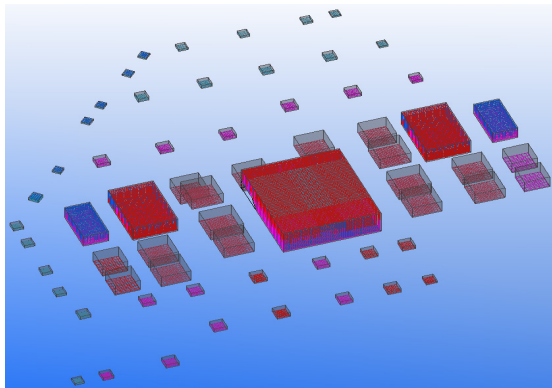
TEKLA Projects



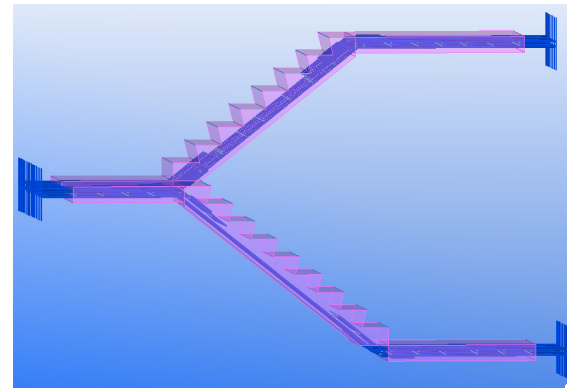
BEAMS AND GIRDERS



COLUMNS



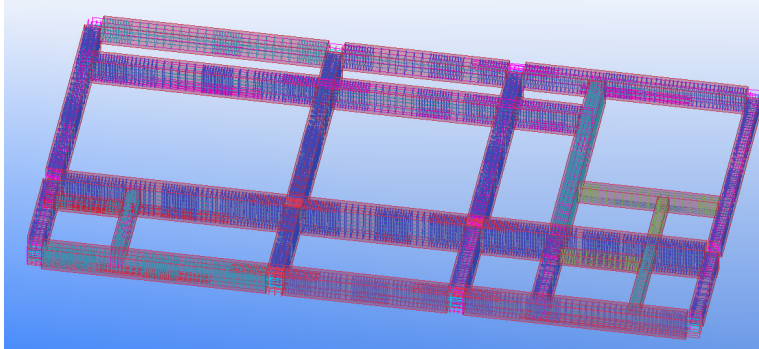
FOUNDATIONS



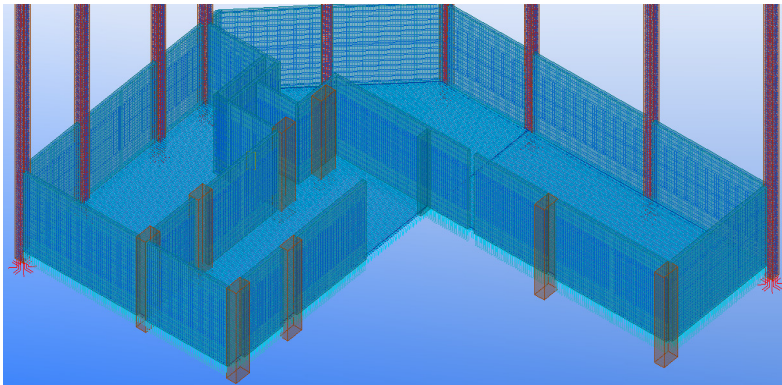
STAIRS



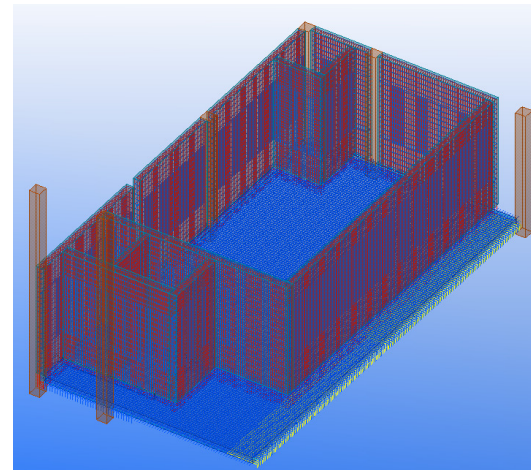
TEKLA Projects



FOOTING TIE BEAMS



DOMESTIC WATER TANK



SEWAGE TREATMENT PLANT



STATUS REPORT

ITEM	DESCRIPTION	UNIT	TSD - TEKLA	CG	VOLUME OF CONCRETE (m ³)
3200	CONCRETE REINFORCEMENT				
	03210 Reinforcing Steel (Installation Only)				
	Grade 40				
	To beams and girders	kg	11,055.88	2,770.94	5160.8
	To stair	kg	3472.00	6,836.11	
	To suspended slab	kg	367,623.86	315,780.80	3892.27
	To slab on grade	kg	32,351.39	19,129.00	524.85
	Grade 60				
	To columns	kg	487,535.87	726,069.91	1936.89
	To beams and girders	kg	1,084,138.49	1,183,683.51	
	To link beams	kg	27754.74	55,406.00	79.32
	To shear wall	kg	1,040,910.13	642,513.89	2663.78
	To stair	kg	20,885.38	32,404.38	515.81
	To footing tie beams	kg	3214.43	-	196.26
	To Mat footing	kg	67,762.83	48,486.54	1,095.19
	To Combined footing	kg	5,179.28		
	To Isolated footing	kg	16,877.85	27,423.00	633.84
	To Cistern & STP	kg	83245.56	-	364
	To suspended slab	kg	32,768.49	61,694.48	
	To Retaining Wall	kg	-	-	
	To lintel beams	kg	-	-	
	To RC Wall	kg	-	-	3612.19
SUB TOTAL REINFORCING BARS		kg	3,284,776.18	3,122,198.56	20,231.88





Accurate Planning and Ordering - Natsteel, Singapore

Overview of Innovative Products and Processes
Developed and Used in NatSteel



5

Reducing Waste with Construction BIM & Prefab

- E.Pihl & Sons (Denmark), and CELSA (Rebar Fabricator)



**BE THE
FUTURE.
NOT A
HAS-BIM.**



Thank you !

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