CLASH ANALYSIS REPORT

Project Number: J032110

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1. GENERAL INTRODUCTION

It is required by _ this project to adopt an integrated Full BIM process throughout the whole project circle. Clash detection analysis, as one of the key process, had been conducted on a deliverable basis during the construction stage. By reviewing the clash analysis results on a regular basis, the process has been facilitating construction coordination among Architectural (ARC), Structural (STR) and mainly Building Services (MEP) disciplines.

2. CLASH DETECTION WORKFLOWS

2.1. CDE and Federated BIM Model

After received the design BIM model from the Consultant, Main Contractor's BIM team have applied Collaboration for Revit to initiate the Revit native files to BIM 360 Team as CDE in construction stage, then BIM models could be updated and reviewed in different locations such as Consultant's office and site office. Because the sub-contractors of building services are not Revit-capable to create and operate the BIM model of their own discipline by Revit, BIM team propose an alternated coordination workflow to engage the sub-contractors into BIM by using Civil 3D.
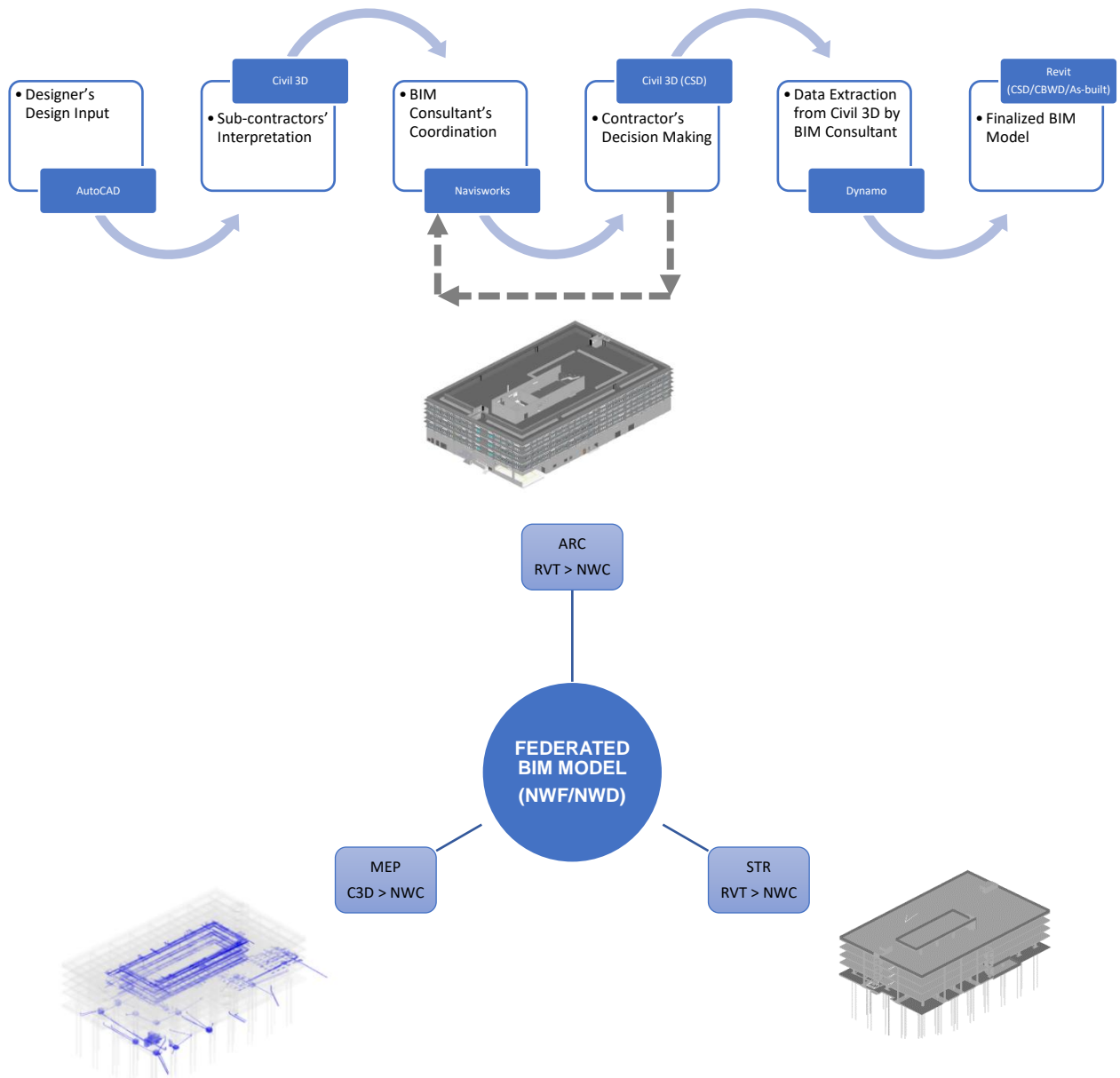
BIM manager will then create a Federated BIM Model by combining ARC, STR and MEP BIM Models, and conduct the clash detection analysis. Clash detection are run with Autodesk Navisworks Manage.

2.2. Clash Matrix

The following tables are clash matrix, used to report and summarize the results of interim clash analysis. Clash analysis has been conducted between STR vs ARC, STR vs MEP, ARC vs MEP, MEP vs MEP. Numbers in different cells are numbers of clashes found in the test. The color fill of each cell shows the clash priority of each test, with red representing the with most priority, yellow representing less priority and green representing least priority.

STR VS ARC	ARC_WALL	ARC_CEIL	ARC_FLOR	ARC_PCF
STR_COLM	16	27	198	0
STR_WALL	80	0	2	0
STR_FODN	2	0	34	0
STR_FRAM	926	0	216	0
STR_STAIR	27	0	13	0
STR_FLOR	211	0	494	0
	STR	VS	ARC	2246

STR VS MEP	MEP_AC	MEP_DR	MEP_EL	MEP_PL	MEP_FS
STR_COLM	5	0	0	0	2
STR_WALL	5	2	7	1	8
STR_FODN	0	15	6	0	0
STR_FRAM	21	14	0	0	740
STR_STAIR	0	0	1	0	11
STR_FLOR	20	38	6	0	17
	STR	VS	MEP		919

ARC VS MEP	MEP_AC	MEP_DR	MEP_EL	MEP_PL	MEP_FS
ARC_WALL	2182	234	221	512	345
ARC_CEIL	116	7	323	25	1
ARC_FLOR	0	44	2	6	16
ARC_PCF	11	0	6	0	0
	ARC	VS	MEP		4051

MEP VS MEP	MEP_AC	MEP_DR	MEP_EL	MEP_PL	MEP_FS
MEP_AC	-	-	-	-	-
MEP_DR	35	-	-	-	-
MEP_EL	63	13	-	-	-
MEP_PL	22	11	14	-	-
MEP_FS	65	10	2	1	-
	ARC	VS	MEP		236

2.3. Clash Issues

BIM team will first review clashes found from every test result, then identify the clash severity base on the PXP's interpretation, which are defined as Major, Minor and Erroneous clash. Interim clash reports will then be generated and distributed before BIM coordination meeting. It is very common that one element found collided with other several elements, in such situation, those clashes found will be grouped and regarded as one clash issue.

2.4. Clash Prioritization

In an interim clash report, sometimes there will be thousands of clashes found, to review all clashes during the coordination meeting will be impractical. Thus, clash results will be prioritized according to the level of clash severity defined in PXP. Only Major clashes and clash issues will be addressed during the BIM coordination meeting. To facilitate the clash severity identification, designer's BIM Manager has developed an add-in tool inside Navisworks, with this tool, users can now let the computer to perform clash prioritization task automatically, based on customizable preset rules. Comparing to go through all clashes one by one manually, which is still very common in practice. The add-in tool has drastically improved the efficiency. The following screen capture diagram shows the overall clash result of SDB including STR vs ARC, STR vs MEP, ARC vs MEP and MEP vs MEP tests.
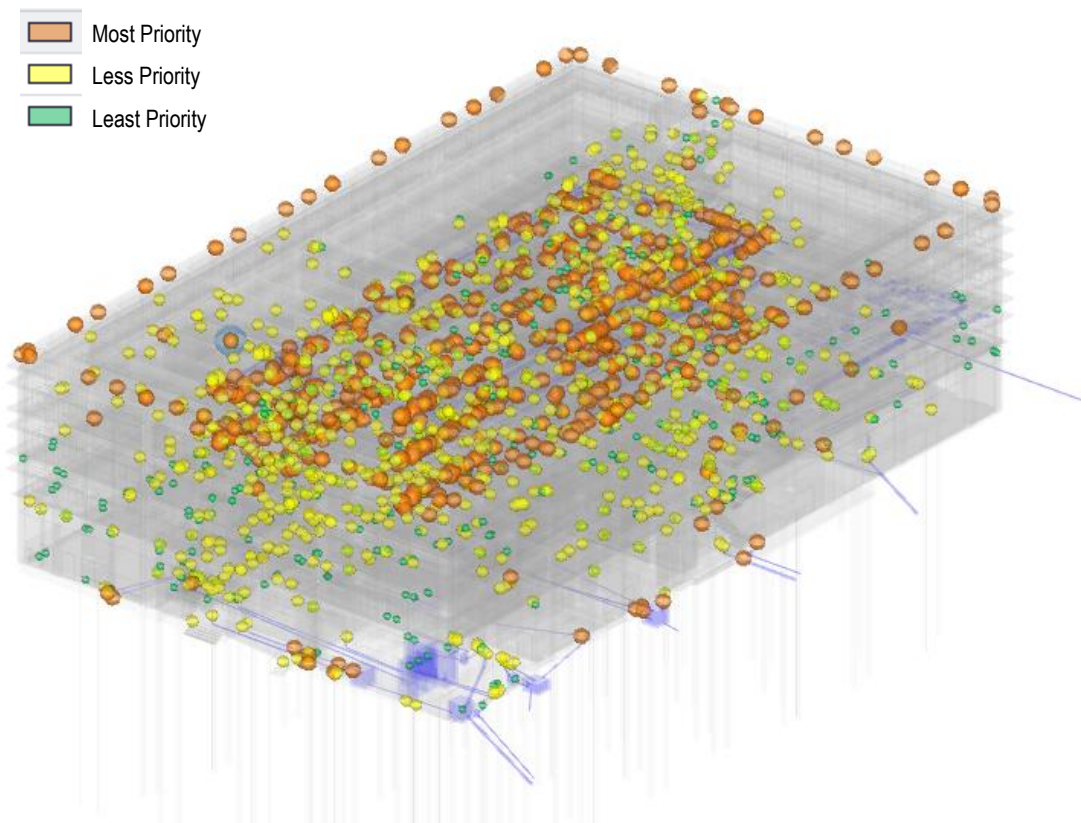
2.5. Clash Resolution

During the coordination meeting with main contractor and all subcontractors, all clashes will be reviewed and major clashes will be discussed, then resolutions will be proposed and discussed on the meeting. When further studies are necessary for complicated issues, BIM team will assist MC's project team to issue RFI/TQ reports to seek resolutions from consultants and designers. A successful clash resolution effort involves collaboration and agreement. The MC's project team will discuss the conflicts and decides which trade will move its components in order to resolve the clash. A general hierarchy tends to guide the process. Clashes between MEP Trades and Structural Elements typically result in MEP items being rerouted to avoid collisions. Pressure pipe may be rerouted to avoid larger items such as sheet metal ducts. Ducts may need to be rerouted to accommodate sloped drainage piping that is restricted by the available vertical clearance within its area of travel.

2.6. Clash Status

In the Clash Report, clash status is categorized as Active, Approved and Resolved.

Active status means clashes new found during the interim clash detection and those clashes remain un-resolved since previous clash detection. In practice, in is very common that, some clashes cannot be resolved during the

coordination meeting, and resolution needs further coordination and studies. In such case, clash status of those clashes will remain Active, until all resolutions are found. However, in the end of the Construction Stage, there should be no Active Clashes left.

Approved status means clashes found during the interim clash detection process, and those clashes are reviewed and defined as acceptable between disciplines. A typical scenario is acceptable penetration of MEP pipes run through Structural Beams or Structural Floors.

Resolved status means clashes found during the interim clash detection, resolutions are proposed and made acceptable between disciplines, and then BIM model will be updated accordingly. After BIM model are updated and further clash detection will be conducted to test whether those clashed are active or resolved. For the resolved clashes Navisworks will move them under resolved status column automatically. During Construction Stage and As-built Stage, resolved clashes will be accumulated and kept in the record, only the lasted resolved clashes will be included in the Clash Report.

2.7. Clash Report Format

To facilitate design coordination, interim clash reports were distributed in both PDF and NWD format, in the PDF file, clashes will be reported with information, such as the clash name, status, grid location and building level, element I.D., etc. To improve the efficiency for BIM model authors to locate the clashes, NWD format are issued to allow modelers to review the clash issues in 3D view, rather than 2D static screen capture images.

3. CLASH ANALYSIS SUMMARY

3.1. STR vs ARC Test

No new Major active clash issues found in this clash analysis. Minor clash issues are detected and approved, where ARC elements and Structural elements are joint or overlapped to each other. Location of each clash can be found in the attached NWD file under "Clash Detective".

STR - ARC	NOC	SEVERITY	STATUS	COMMENT
STR_FODN VS ARC_WALL	2	MI	AP	Geometry joint
STR_COLM VS ARC_WALL	16	ER	AP	
STR_COLM VS ARC_CEIL	27	ER	AP	
STR_WALL VS ARC_WALL	80	ER	AP	
STR_FODN VS ARC_FLOR	34	MI	AP	Surface overlapping
STR_COLM VS ARC_FLOR	198	MI	AP	Geometry joint
STR_FRAM VS ARC_WALL	926	ER	AP	
STR_FRAM VS ARC_FLOR	216	ER	AP	
STR_WALL VS ARC_FLOR	47	ER	AP	
STR_STAIR VS ARC_WALL	27	MI	AP	Geometry joint
STR_STAIR VS ARC_FLOR	13	MI	AP	Geometry joint
STR_FLOR VS ARC_WALL	211	ER	AP	
STR_FLOR VS ARC_FLOR	494	ER	AP	
TOTAL	2291			

3.2. STR vs MEP Test

Several Major active clash issues detected in this clash analysis, all appear in the underground area, where electrical cable lead-in found collided with structural elements. They are approved after reviewed on coordination meeting as it is the correct construction issue.

STR - MEP	NOC	SEVERITY	STATUS	COMMENT
STR_FODN VS MEP_EL	6	MA	AP	Cable lead-in
STR_FODN VS MEP_DR	15	ER	AP	Pipe collide with Surface channel to collect water, clash approved
STR_COLM VS MEP_AC	5	MI	AP	
STR_FRAM VS MEP_AC	21	ER	AP	
STR_FRAM VS MEP_DR	14	MI	AP	
STR_WALL VS MEP_EL	7	MI	AP	
STR_WALL VS MEP_AC	5	MI	AP	
STR_WALL VS MEP_DR	2	MI	AP	
STR_COLM VS MEP_FS	2	ER	AP	
STR_WALL VS MEP_PL	1	MI	AP	
STR_STAIR VS MEP_EL	1	MI	AP	
STR_FLOR VS MEP_EL	6	MI	AP	
STR_FLOR VS MEP_AC	20	MI	AP	
STR_FLOR VS MEP_DR	38	MI	AP	
STR_FRAM VS MEP_FS	740	ER	AP	Pipes penetration
STR_WALL VS MEP_FS	8	ER	AP	Pipes penetration
STR_STAIR VS MEP_FS	11	MI	AP	Pipes penetration
STR_FLOR VS MEP_FS	17	MI	AP	Pipes penetration
TOTAL	919			

3.3. ARC vs MEP Test

Most of clashes can be approved because the penetration in architecture wall is acceptable. And some erroneous clashes are found such as surface overlapping, ceiling mounted items, cable lead-in, etc. They can all be approved after review on coordination meeting.

ARC VS MEP	NOC	SEVERITY	STATUS	COMMENT
MEP_AC VS ARC_WALL	2182	MA	AP	Penetration in architectural wall is acceptable
MEP_AC VS ARC_CEIL	116	ER	AP	Insulation overlapping with false ceiling, headroom requirement is satisfied
MEP_DR VS ARC_WALL	234	MI	AP	Penetration in architectural wall is acceptable
MEP_EL VS ARC_WALL	221	MI	AP	Penetration in architectural wall is acceptable
MEP_EL VS ARC_FLOR	2	ER	AP	Cable lead-in
MEP_EL VS ARC_CEIL	323	ER	AP	Ceiling mounted lighting is acceptable
MEP_EL VS ARC_PCF	6	MI	AP	
MEP_FS VS ARC_WALL	345	MI	AP	Penetration in architectural wall is acceptable
MEP_AC VS ARC_PCF	11	ER	AP	Duct louvre
MEP_PL VS ARC_WALL	512	MI	AP	Penetration in architectural wall is acceptable
MEP_DR VS ARC_FLOR	44	ER	AP	Pipe collide with Surface channel to collect water, clash approved
MEP_DR VS ARC_CEIL	7	ER	AP	
MEP_PL VS ARC_FLOR	6	ER	AP	
MEP_PL VS ARC_CEIL	25	ER	AP	
MEP_FS VS ARC_FLOR	16	ER	AP	
MEP_FS VS ARC_CEIL	1	ER	AP	
TOTAL	4051			

3.4. MEP vs MEP Test

No Active clash issues remain as the minor clashes left are to be adjusted on with sufficient space.

MEP VS MEP	NOC	SEVERITY	STATUS	COMMENT
MEP_AC VS MEP_DR	35	MI	AP	To be adjusted on site with sufficient space
MEP_EL VS MEP_AC	63	MI	AP	To be adjusted on site with sufficient space
MEP_EL VS MEP_DR	13	MI	AP	To be adjusted on site with sufficient space
MEP_FS VS MEP_AC	65	MI	AP	To be adjusted on site with sufficient space
MEP_FS VS MEP_DR	10	MI	AP	To be adjusted on site with sufficient space
MEP_AC VS MEP_PL	22	MI	AP	To be adjusted on site with sufficient space
MEP_PL VS MEP_DR	11	MI	AP	To be adjusted on site with sufficient space
MEP_EL VS MEP_FS	2	MI	AP	To be adjusted on site with sufficient space
MEP_EL VS MEP_PL	14	MI	AP	To be adjusted on site with sufficient space
MEP_FS VS MEP_PL	1	MI	AP	To be adjusted on site with sufficient space
TOTAL	236			

4. CLASH ISSUES SUMMARY

4.1. STR VS ARC

Over 2000 clashes found during the clash detection analysis, no major issues and most of clashes are erroneous clashes including geometry joint and surface overlapping.

4.2. STR VS MEP

To further improve the coordination efficiency, MEP subcontractors was instructed to create the BIM model by using Civil 3D initially. Clash analysis were conducted within Navisworks accordingly. After two or three coordination meetings and active clashes are narrowed down to a certain number, BIM team convert the Civil 3D model into Revit by using Dynamo for further clash detection and coordination.

As the STR model is more consolidated and MEP have more flexibility, clashes between these two disciplines are mainly resolved by moving the MEP elements during coordination meetings by subcontractors and agreed by main contractor. There are less than 1000 clashes and all of them have been reviewed and approved.

4.3. ARC VS MEP

There are over 4000 clashes are detected between ARC and MEP but over half of them are AC system clashing with architectural wall, which could be approved because penetration in architectural wall is acceptable.
No other major clash issues were detected between ARC and MEP BIM models. Several minor clash issues are detected between wall and other building services which can also be approved by penetration in wall. For clash issues found between MEP elements (ducts and pipes) and architectural internal partition walls, after reviewed on several meetings, generally twice, those clash issues were made acceptable among disciplines. The Clash detection test is also known as soft clash detection, which is commonly used to review if the head-room requirements are satisfied between ceiling and MEP.

4.4. MEP VS MEP

There are only 236 minor clashes left among all MEP trades clashing with each other. All of them have been reviewed and approved by MEP subcontractors and main contractor to ensure all clashing items remained could be adjusted on site with sufficient space.

5. CONCLUSION

Although BIM work flow has not been 100% adopted in Shatin Decanting Building, clash detection as one of the key process in full BIM implementation for this project, has been carried out successfully. During the construction stage, clash detection analysis has been conducted and submitted on a floor basis, following the requirement in Project BIM Execution Plan. Clash issues have been reviewed on coordination meetings, respective resolutions have been proposed and adopted, thus improve the efficiency of coordination among main contractors and subcontractors.

NWD files with clash detection results are provided as supplementary document for BIM Auditor's review.