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Application of Building Information Modeling (BIM) for Escape Shaft during Construction Stage in T207 Thomson-East Coast Line, Singapore

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This paper is to present the technical and design challenges at Escape Shaft (ES-2) after additional site investigation (SI) discovered higher rockhead elevation as well as discussing the impact of the application of BIM on cost and time consumption for T207 Project located in Northern part of Singapore.

1. INTRODUCTION

ES-2 is a 34m deep shaft served as important shaft as it is the receiving shaft for four Tunnel Boring Machines (TBMs) and construction of Rapid Transit System (RTS) Facility Building during the construction phase. It is crucial that the excavation of ES-2 shaft to be on schedule to avoid any delay damage on the overall construction activities. General description of location of ES-2 and project T207 is shown in Figure 1a and BIM model illustration in Figure 1b.

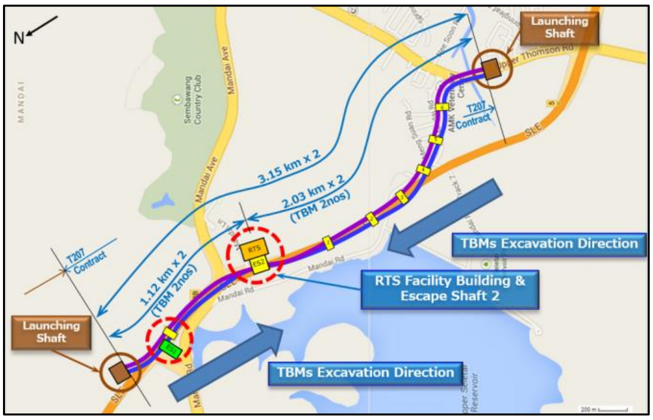

Figure 1a: Project layout which shows ES-2 location and direction of TBMs.

Figure 1b: BIM model of ES-2 and RTS facility building on top.

2. GEOLOGICAL CONDITION

ES-2 excavation was expected to be mostly in soil and about 20% in moderately weathered GRANITE (GIII grade) where soil excavation was expected to be at depth 20m to 30m depth. However, after additional soil investigations were carried out, the rockhead at one corner of ES-2 was found to be 10m higher than the original expected depth. Besides that, the rock also found to be in much harder and fresher GRANITE of GI-GII grade.

Due to the higher rockhead elevation, the Earth Retaining Stabilizing Structure (ERSS) design of the strut is significantly affected where there is change of support from soil (secant bore pile (SBP) wall) to rock support (rock bolts and shotcrete). The changes of the rockhead elevation is shown in Figure 2

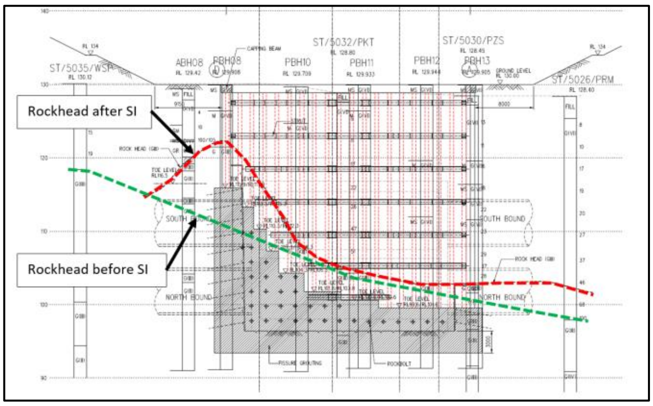

Figure 2: One of ES-2 geology profile cross section shows that the change of rockhead height.

Higher rockhead means that SBP wall is also significantly shorter which translate into shorter time frame for the SBP wall construction. However at the same time, this would also means that the excavation in rock could be more time consuming since the rock quantity and hardness is higher than expected.

3. APPLICATION OF BIM

With the unexpected changes on the rockhead level in ES-2, it is difficult to ensure that the re-design of ERSS in short duration (between the period of SI and shaft excavation consist about 3-4 months) can be executed correctly and safely without lengthy calculations and checking. However, with the implementation of BIM in T207, the change of rockhead elevation can be cope with better visualization which lead to faster and better decision making on the re-design of ERSS of ES-2 as shown in Figure 3. All the SI date can be compiled and visualized and design review in 3D with the distinctive of the rock head changed.

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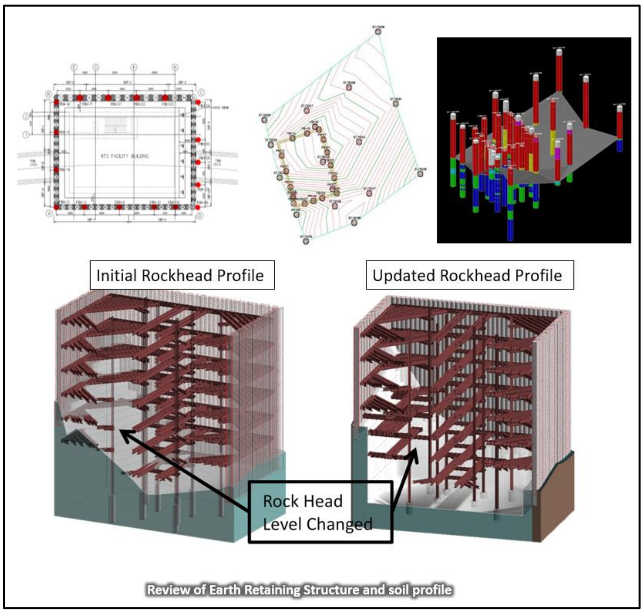

Figure 3: Compilation of SI data and establishment of rockhead profile.

After the establishment of the rock head profile, following ERSS re-design can be proceed by using the model if the initial design has clashed or not applicable as example shown in Figure 4.

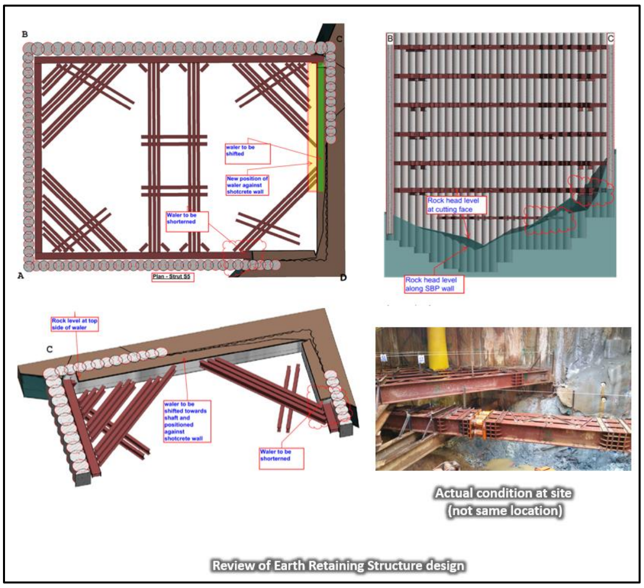

Figure 4: Review can be easily carried out by using BIM.

4. PROGRESS AND CHANGES APPLIED

With the application of BIM on ES-2 excavation, the work could be carried out smoothly with better estimation of the quantity of soil and rock excavation. Besides that, the ERSS design in ES-2 can be carried out with better view of the site based on the BIM model and the struts or steel members could be determined in short period of time without causing delay to the overall construction of ES-2.

Additionally, blasting plan can be established provided the detail of the rock quantity and smooth arrangement between contractor and authority can be carried out accordingly without delay. With the increase of rockhead elevation in ES-2, the ERSS design where the strutting is to adjust to fit into the new rock profile.

ES-2 consisted of 7 layers of struts with spacing of 5m in between. The changes were made on strut layer No.4, No. 5 and No.6 where layer No.5 is the most distinctive which a section of diagonal strut removed and replaced by a couple horizontal struts as shown in Figure 5 and Figure 6. The design change could be determined in a short period of time with the BIM application where the detection of crashes between the new rock surface and initial design of ERSS.

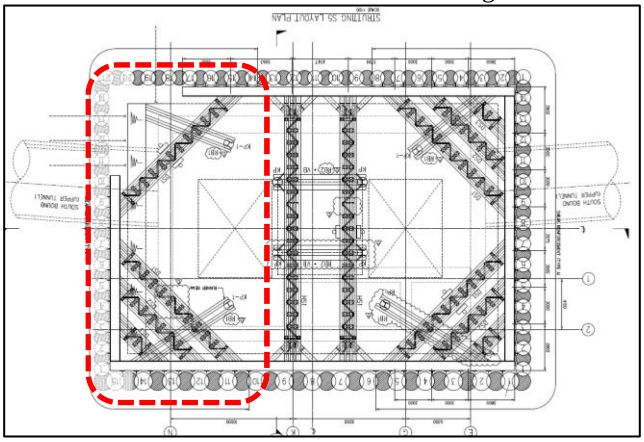

Figure 5: Initial design of strut layer No. 5 where diagonal struts were installed on all corners. Marked with red is the affected area.

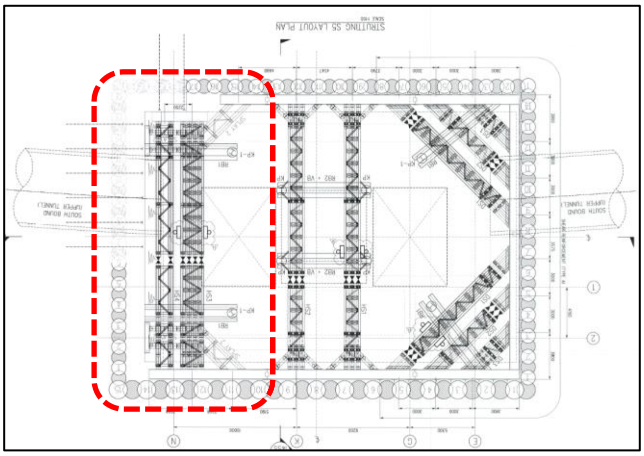

Figure 6: Re-design of strut No.5 after discovery of high rockhead. Diagonal struts were removed due to the present of rock and replaced with horizontal struts. Marked with red is the affected area.

5. CONCLUSION

With the application of BIM 3D modelling, re-design can be achieved in a short period of time and avoided critical delay of the project for un-anticipated event such as the discovery of rockhead elevation change and others. It proves that BIM application are useful for easy visualization and checking during construction stage.

Reference:
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