The MTR Tsim Sha Tsui (TST) Station Modification Works included deep excavation and pedestrian subway construction at busy urban area. The excavation for the subway was as close as 1.5m above the crown of an operating MTR tunnel and the temporary retaining structures a similar distance from the side of the tunnels. The works was therefore associated with high risk. Risk management and mitigation became an extremely critical issue to the success of this project. The challenges and the experience were discussed in this ground forum from three different perspectives.

Project Risk Management (by Mr. Julian Saunders)

Mr. Julian Saunders started off the forum by introducing briefly the concept of risk, the ALARP (As Low As Reasonably Practicable) principle to balance risk and economy and the use of risk matrix. Then, the project risk management system approach adopted was described. Contrary to the traditional, passive approach in which problems are only dealt with when problems arise, the risks are dealt with in a proactive manner. Teams of engineers were set up to identify new risks both inside and outside the construction site. Regular meetings were held to update the risk register in which new risks and new mitigation measures were noted. Ground movement, which is the most catastrophic risk for existing buildings and tunnel, was monitored closely by numerous instrumentations. At the end, 348 risks were identified, among which only about 100 were foreseen before the construction commenced. The value of insurance claims is $284,000, which is relatively low for such a high-risk project, and is only 55% of tender allowance on risk mitigation cost. The results showed the importance of a proactive approach in risk management, particularly in high-risk project. Finally, Mr. Saunders commented on the high cost of construction insurance and proposed that with good risk management, a case can be put forward to insurance company to reduce its rate.

Risk Assessment and Prediction - Designer's perspective (by Michael Lacy)

In the second presentation, Mr. Michael Lacy explained the importance of considering real construction situations for designers. As the deep excavation temporary works designer, the main concern was ground settlement, which is caused by installation of wall, excavation and dewatering. Settlement due to wall installation can only be assessed by experience, while that due to excavation and dewatering were predicted by FLAC modeling and seepage analysis respectively. The design was optimized by considering various wall options and construction sequences. At the end, the final design was a combination of pipe piles and sheet piles with toe grouting. As the geotechnical parameters are always subjected to uncertainty, sensitivity analyses were carried out to predict a possible range of ground movement. Instruments were installed to monitor the movements, which were found to be less than the prediction.

Risk Management – Contractor's perspective (by Phil Gunning)

In the last presentation, Mr. Phil Gunning reviewed the major risks. These are tunnel deformation, tunnel floatation if cofferdam was flooded and building settlement. Regarding construction, Giken Press-In piling method and Gammon Closed Loop Pipe Pile System were chosen to install sheet piles and pipe piles respectively to minimize noise, vibration, ground disturbance and water ingress into the cofferdam. The Closed Loop System was also compared with the conventional Down the

Hole Hammer. To prevent floatation and deformation of existing tunnel, ballast was maintained above the tunnel at all time during excavation. Because of the high risk, extensive instrumentation was installed to monitor the tunnel and ground continuously. Despite the huge amount of data, spreadsheets were used to analyze the data automatically. A maximum tunnel deformation of 9mm (upwards) was measured at the tunnel crown and was less than the alert level of 12mm. Maximum building movement recorded was 4mm, which is satisfactory. Despite one flooding incident, the instrumentation indicated that trains can still operate safely in the tunnel. This highlights the importance of having adequate instrumentation, otherwise, the MTR tunnel might have to stop service at a very busy time. There were not many problems and the work was finished ahead of schedule.

Conclusion

In this forum, invaluable experience from three different perspectives – designer, contractor and project manager - were shared with the audience. This covers the identification, monitoring, assessment, mitigation and management of risks in the MTR TST station modification works. This was followed by a question and answer session. Many questions were raised by the audience. One of these addressed whether the existing tunnel's lining can be modified to reduce its sensitivity to the nearby deep excavation works. It was said that precast concrete segmental lining can be strengthened by a 200mm layer of grouting. Another view was to avoid damage by making the tunnel lining more flexible, for example, by releasing some bolts and installing compressible washer at the joints. Mr. Saunders' comments on construction insurance were revisited and discussed.

To conclude, this ground forum successfully encouraged a sharing of experience and knowledge for the experienced, and a good overview of risk management for young engineers.