



*The Hong Kong Polytechnic University
Department of Land Surveying & Geo-Informatics*

Recent Advances of Engineering Survey Operations for Tunnel Construction in Hong Kong

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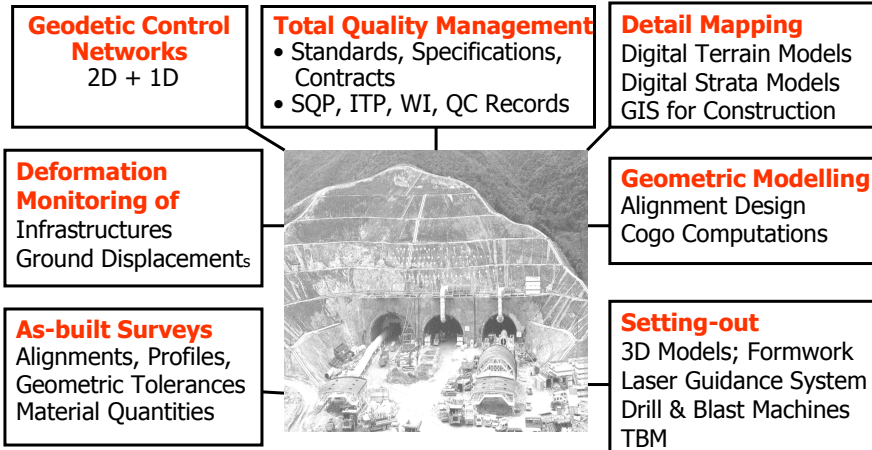
Topics:

1. Engineering survey operations for tunnel construction
2. Geodetic control and deformation monitoring
3. Topographic mapping and geometric modeling
4. Setting-out and as-built surveys
5. TQM under ISO 9001
6. Conclusions
7. Q & A

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1. Engineering survey operations



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2. Geodetic control and deformation monitoring

- ❑ **Horizontal control** by a combined network of triangulation, trilateration, traverse and GPS
- ❑ **Vertical control** by geodetic leveling, and by GPS heighting w.r.t. local geometric geoid
- ❑ **Structural Health Monitoring (SHM)** by a combined geodetic and geotechnical model.
- ❑ From measured displacements and vibration, stiffness of structural element is determined by **reverse engineering analysis**
- ❑ Rely more on geodetic data because it is difficult to re-calibrate geotechnical instruments after installation
- ❑ Use of **airborne InSAR** in monitoring apron areas is highly cost-effective

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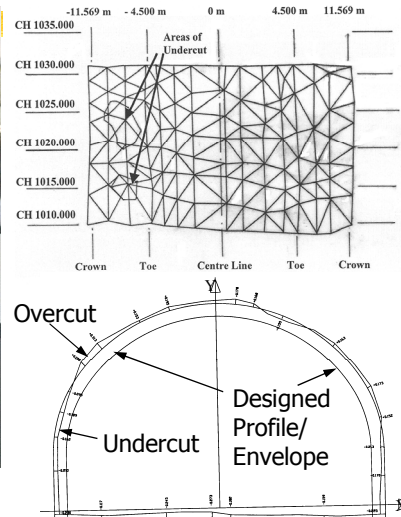
3. Topographic mapping and geometric modeling

- ❑ Details on ground surface and underground are mapped according to ISO 19100 into **GIS/CAD** for project planning/appraisal, engineering design, **geometric modeling** and construction
- ❑ **GIS data**: lot boundaries, buildings, roads, utilities, topography, street directory maps, borehole records, geological maps, rainfall records, ground water conditions, etc.
- ❑ **Mobile Mapping System** integrates data from GPS receiver, IMU, laser scanners and digital camera which can be mounted on trucks, hydro vessels or aircrafts.

4. Setting-out and as-built surveys

- ❑ Setting-out of TBM, Drill & Blast Machine, laser guidance system, precast liners and slipform by **auto-tracking total station**
- ❑ **As-built surveys** by:
 - (1) **Reflector-less total station**, profiler software (e.g., Leica/Amberg's TMS)
 - (2) **Mobile Mapping System**, (e.g., Swiss Trolley of Terra International), equipped with inclinometers, track gauge, odometer, reflector, GPS receiver, LIDAR scanners, digital camera and data collector
 - (3) **LIDAR/imagery scanner**, needs tunnel software (e.g., Optech's ILRIS-3D, Topcon's Imaging System)

Low-cost profiler from second-hand electronic theodolite, distometer, PC



MSc Geomatic Project

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5. TQM under ISO 9001

- Reported in:
- Lam, S. (2010). TQM of Engineering Survey Operations under ISO 9001 in Hong Kong.
- *Proceedings*, FIG Congress 2010, Sydney, Australia, 11-16 April, 2010

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6. Conclusions

- Recent advances of tunnel surveying in Hong Kong include:
- Combined geodetic and geotechnical approach in SHM
- Use of mobile mapping system in detail surveying and mapping
- GIS for construction
- New models of auto-tracking total station for setting-out tunnel liners and tunneling machines
- New models of reflector-less total station, tunnel software, survey trolley and LIDAR scanner for as-built surveys
- TQM of the survey operations under ISO 9001 (2008)

7. Questions & Answers

Thank you.